MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

TECHNICAL SPECIFICATION

EE&QA-886

Procurement of OCS Inspection Car Consists for MBTA Green and Blue Lines

ISSUED: December 15, 2020

REVISION: 2.0

EQUIPMENT ENGINEERING AND QUALITY ASSURANCE

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1 SCOPE OF SPECIFICATION

1.1 GENERAL

1.1.1 The Massachusetts Bay Transportation Authority (MBTA) seeks to procure dedicated rail, self-propelled Overhead Contact System (OCS) Inspection Car Consists.

1.1.2 This Technical Specification ("Specification") establishes and controls both the specific and general design parameters for the procurement of dedicated rail, self-propelled OCS Inspection Car Consists to be used primarily for inspection and light maintenance of the OCS.

1.1.3 The OCS Inspection Car Consists will be procured for operation and use on the MBTA Light Rail and Rapid Transit Lines known as the Green and Blue Lines respectively. These OCS Inspection Car Consists will NOT be used on the MBTA's Commuter Rail Lines.

1.1.3.1 The MBTA intends to buy a total of two (2) OCS Inspection Car Consists as indicated below:

1.1.3.1.1 One (1) OCS Inspection Car Consist for operation on the MBTA Green Line.

1.1.3.1.2 One (1) OCS Inspection Car Consist for operation on the MBTA Blue Line.

1.1.3.2 Each Transit Line has different technical specifications, but the MBTA seeks to procure a common OCS Inspection Car Consist with minor modifications to meet the Transit Line's individual specifications.

1.1.3.3 The differences and similarities between the Transit Lines are defined within Section 2 of this Specification.

1.1.4 The MBTA is seeking OCS Inspection Car Consists with the performance and functional characteristics identified within this Specification. The requirements are written with an intention to allow a variety of designs, configurations, and use of service proven designs.

1.1.5 This Specification provides guidelines and requirements for a competent, experienced Contractor to design, manufacture, test, furnish, and deliver the specified vehicles. The MBTA encourages Contractors to propose service proven designs that meet, exceed, or provide a similar and comparable feature to the requirements of this Specification.

1.1.6 All equipment provided under this Contract shall be new. Rebuilt or refurbished equipment is prohibited.

1.1.7 Should conflicts exist or an item or feature is deemed by the Contractor not to be adequately described or explained in this Specification, the Contractor shall apply to the MBTA in writing for further explanation.

1.2 OCS INSPECTION CAR CONSIST KEY REQUIREMENTS

1.2.1 **Key Requirements for the OCS Inspection Car Consists include, but not limited to:**

1.2.1.1 The MBTA has developed this Specification based on industry research and response to a Request for Information with the assumption that a two-vehicle consist (e.g. – Inspection Car and a Maintenance Car) will be proposed and configured to maximize the requirements of this Specification and intended uses.

1.2.1.1.1 Contractors may propose other consist configurations that meet or exceed the specifications described herein and will be reviewed by the MBTA without prejudice.

1.2.1.2 The OCS Inspection Car Consists shall be equipped with service proven systems and equipment that meet industry standards for rail-bound work vehicles or as specified within this Specification.

1.2.1.2.1 Where service proven designs are proposed, the MBTA may at its discretion, waive any requirements within this Specification.

1.2.1.2.2 Where service proven designs are NOT proposed, the technical requirements of this Specification along with any additional requirements the MBTA imposes shall be met.

1.2.1.2.3 The MBTA expects that the Contractor will use service proven designs wherever possible to minimize risk, cost, and schedule.

1.2.1.3 The OCS Inspection Car Consists shall have the ability to traverse and operate on the entire Green and Blue Line Rights-of-Way (ROW). The ROWs may include, but not limited to:

1.2.1.3.1 Tunnels, bridges, grades up to 8%, curvatures down to a minimum horizontal radius of 45 feet, maximum superelevation of 6.5 inches, operation in close proximity to electrified 3rd rail and overhead catenary, operation through all environmental conditions, operation within the clearances of the ROW, Operation on non-dedicated (street running) ROW, and all other ROW aspects.

1.2.1.3.2 Additional detailed minimum performance and system requirements are provided in Section 2 of this Specification. Track charts are provided in Appendix G.

1.2.1.4 The OCS Inspection Car Consists for the Green and Blue Lines shall be identical, although some equipment may be omitted where not required, and bolt-on equipment may be repositioned.

1.2.1.4.1 Each OCS Inspection Car Consist will operate on a single Transit Line and not be moved between lines.

1.2.1.5 The OCS Inspection Car Consists shall be of a dedicated rail design and operate independently under normal conditions and be operable in both directions.

1.2.1.5.1 High rail type designs will NOT be accepted.

1.2.1.6 The OCS Inspection Car Consists shall have the capability of running between revenue service trains during off-peak hours to perform inspection and light maintenance.

1.2.1.6.1 The OCS Inspection Car Consists shall be equipped with track signal shunting capabilities.

1.2.1.6.2 A positive stop feature shall be provided by wayside trips on the Blue Line OCS Inspection Car Consist.

1.2.1.7 The OCS Inspection Car Consists shall be equipped with a primary diesel/battery hybrid power system. Primary power may NOT be obtained from the third rail or OCS.

1.2.1.8 The OCS Inspection Car Consists shall be equipped with one or more Operator Stations to enable full operation in either the forward or reverse directions at maximum operating speed.

1.2.1.9 The OCS Inspection Car Consists shall be equipped with an OCS inspection system to view, measure, and record impact, wire stagger, wire height, wire wear, and location.

1.2.1.10 The OCS Inspection Car Consists shall have the ability to record thermal and visual measurements.

1.2.1.11 The OCS Inspection Car Consists shall be equipped with electrically insulated maintenance personnel lifts, including a vertical lift and bucket lift, to allow a crew of up to 5 to perform maintenance and wiring installation activities on live 800 VDC OCS.

1.2.1.12 The OCS Inspection Car Consists shall have an electrically insulated wire feed system with adjustable tension brake that is compatible with an MBTA wire reel.

1.2.1.12.1 The system shall provide for mounting of two (2) wire reels. One for the contact wire and other for messenger wire.

1.2.1.13 The OCS Inspection Car Consists shall be capable of carrying crew members and operators to and from work sites.

1.2.1.14 The OCS Inspection Car Consists shall be equipped with a Crew Cabin with seating, work bench, space for tools and storage of materials.

1.2.1.15 The OCS Inspection Car Consists shall have all safety features required in this Specification to reduce the risk of injury in the event of a collision.

1.3 OCS INSPECTION CAR CONSIST FEATURES AND SYSTEM REQUIREMENTS

1.3.1 The general features and requirements of the OCS Inspection Car Consists are summarized below by system. This list is not intended to be all inclusive but is meant to provide the Contractor an overview of this Specification. The specific requirements and details can be found in the referenced sections and within the Key Requirements listed above in Section 1.2.

1.3.2 **System Design (Section 2)**

1.3.2.1 Section 2 of this Specification provides requirements for the features, functions, system performance, and the general design criteria for the OCS Inspection Car Consists. It provides specific requirements for the following:

1.3.2.1.1 Acceptable vehicle loading and weights, use of service proven design, car dimensions and clearance, the MBTA's operating environment, operating and braking performance, duty cycles, electromagnetic compatibility and interference, and noise, shock, and vibration.

1.3.3 Carbody System (Section 3)

1.3.3.1 Section 3 of this Specification provides requirements for the design, construction, and features of the Carbody system. It provides specific requirements for the following:

1.3.3.1.1 Service Proven Design including alternate compliance requests for the Carbody Assembly in lieu of specified requirements.

1.3.3.1.2 Design Loads along with Equipment Attachment Strengths.

1.3.3.1.3 Anti-Climbers and their use on the ends of the vehicles.

1.3.3.1.4 Jacking and Lifting Provisions to enable the MBTA to utilize its existing portable electric car jacks.

1.3.3.1.5 Safety Appliances such as sill and hoop steps, handholds, railings, and ladders.

1.3.3.1.6 Analysis and Testing, if applicable to the proposed design.

1.3.4 Coupler System (Section 4)

1.3.4.1 Section 4 of this Specification provides requirements for coupler equipment that will enable the OCS Inspection Car Consists to be towed by a revenue vehicle consist in the event of an OCS Inspection Car Consist failure. It provides specific requirements for the following:

1.3.4.1.1 Integration of the MBTA-provided coupler systems onto the ends of the OCS Inspection Car Consists to enable automatic mechanical coupling. This includes different types of couplers for the Blue and Green Lines.

1.3.4.1.2 Coupler heights for the OCS Inspection Car Consists on the Blue and Green Lines.

1.3.4.1.3 Pneumatic and Electrical connections between OCS Inspection Car Consist vehicles.

1.3.5 Operator Stations and Crew Cabin (Section 5)

1.3.5.1 Section 5 of this Specification provides requirements for the Operator Stations and Crew Cabin. It provides specific requirements for the following:

1.3.5.1.1 Operator Stations and Crew Cabin Enclosures, including the ability for safe movement from both ends of the OCS Inspection Car Consists at maximum operating speed.

1.3.5.1.2 General Arrangement, including arrangement of a single or multiple enclosed spaces to safely transport one (1) operator and six (6) crewmembers and provide space for a utility area .

1.3.5.1.3 Construction, including use of existing MBTA crew keys on doors, FRA Type windshields, sliding side windows for operator use, and an emergency exit plan.

1.3.5.1.4 Operator Station and Crew Cabin Equipment, including all controls, indicators, communication equipment, operator view / thermal cameras and DVR systems, lighting, seating, heating, ventilation, and cooling.

1.3.6 Propulsion System (Section 6)

1.3.6.1 Section 6 of this Specification provides requirements for the propulsion system. It provides specific requirements for the following:

1.3.6.1.1 System configuration, including Diesel / battery hybrid propulsion system with electric, hydrostatic, or other type transmission, EPA Tier 4 final engine, and main battery capacity for an eight-hour work shift.

1.3.6.1.2 Controls, Transmission, Diesel Engine, and Main Battery, including operating modes, maintainability, fuel / DEF systems, fire protection, battery capacity, and required design submittals.

1.3.7 Trucks and Suspension System (Section 7)

1.3.7.1 Section 7 of this Specification provides requirements for the truck and suspension system and assumes a dedicated rail vehicle with two-axle, freight or passenger trucks will be provided. It provides specific requirements for the following:

1.3.7.1.1 General Design, including use of APTA, AAR, or EN standards for truck design. Direction is provided if alternate standards or design guidelines would like to be proposed as well as structural design analysis and testing.

1.3.7.1.2 Wheels, axles, and journal bearings, including types, profiles, manufacturing specifications, and truing provisions utilizing the existing MBTA wheel true machines.

1.3.7.1.3 Suspension system, including general design and dynamic performance.

1.3.7.1.4 Snowplows, including the MBTA's preference for mounting at the outboard ends of the end trucks, and adjustability.

1.3.8 Friction Brake System (Section 8)

1.3.8.1 Section 8 of this Specification provides requirements for the friction brake system and defines a pneumatically actuated and controlled system. It provides specific requirements for the following:

1.3.8.1.1 A pneumatic friction brake system comprising of AAR-approved air brake components. Direction is provided if brake equipment conforming to EN or other standards is proposed.

1.3.8.1.2 Brake Performance, Configuration, and Equipment, including use of the Brake Pip for trainlining air, use of emergency braking devices such as deadman feature, trip cocks and emergency brake valves, incorporation of a sanding system, and Parking brakes to be located on each car of the OCS Inspection Car Consists. Direction is provided if alternate configurations are proposed.

1.3.9 Electrical System (Section 9)

1.3.9.1 Section 9 of this Specification provides requirements for the electrical system. It provides specific requirements for the following:

1.3.9.1.1 Configuration, including available power supplies, backup power, convenience outlets, circuit protection, and grounding.

1.3.9.1.2 Lighting System, including types such as, headlights, warning, stop / tail, console, exterior, interior, and work lights. Use of LED lights throughout the cars is identified.

1.3.9.1.3 Monitoring and Diagnostic System, including general function and physical requirements.

1.3.10 Communications and Event Recorder System (Section 10)

1.3.10.1 Section 10 of this Specification provides requirements for the communications and event recorder system. It provides specific requirements for the following:

1.3.10.1.1 Intercom system, public address (PA) system, event recorder, and provisions for installing an MBTA provided radio system.

1.3.11 OCS Wire Inspection System (Section 11)

1.3.11.1 Section 11 of this Specification provides requirements for the OCS Wire Inspection system. It provides specific requirements for the following:

1.3.11.1.1 Type of physical inspection equipment. This includes an inspection pantograph, on-board work-station, cameras, and lighting.

1.3.11.1.2 Type of measurement systems and devices. This includes measurement of impact, wire wear, wire stagger, wire height, thermal imaging, location, and visual inspection.

1.3.11.1.3 Overall operation in a semi-automated fashion with viewing of live video and data measurements.

1.3.12 Wire Maintenance Lifts and Wire Reels (Section 12)

1.3.12.1 Section 12 of this Specification provides requirements for the maintenance personnel lifts and wire reel. It provides specific requirements for the following:

1.3.12.1.1 Types of electrically insulated lifts, including a vertical lift to allow 4 crew members to perform OCS inspection, maintenance, and wire replacement and bucket lift to allow access to the messenger wire, cantilevers, head spans, or other components located above the contact wire or on the OCS poles.

1.3.12.1.2 Lift capabilities, including operation while the vehicle is in motion, equipment to perform wire handling, strength and stability, height and clearance, and operational controls.

1.3.12.1.3 Two wire reels, including storage, electrical insulation, size of existing reels, and overall use.

1.3.13 **Software Systems (Section 13)**

1.3.13.1 Section 13 of this Specification provides requirements for Software Systems to be utilized on the OCS Inspection Car Consist. It provides specific requirements for the following:

1.3.13.1.1 Software Management, Hardware, Configuration, and Quality Assurance.

1.3.14 **Testing Program (Section 14)**

1.3.14.1 Section 14 of this Specification provides requirements for a comprehensive testing program to ensure compliance with this Specification and with the Contractor's proposed design. It provides specific requirements for the following:

1.3.14.1.1 Development and Execution of a Testing Program, including qualification, pre-shipment, conformance, and acceptance tests the MBTA wishes to be executed both at the Contractor's facility and on MBTA Property. The details of each specific test are expected to be developed by the Contractor and approved by the MBTA.

1.3.14.1.2 Test Reporting and MBTA Witnessing, including the submittal of test plans and reports, and providing the MBTA the option to witness any test firsthand.

1.4 APPENDIX LIST

Appendix A – Materials and Workmanship Requirements

1.4.1 The Contractor may propose alternative requirements in lieu of the Materials and Workmanship requirements identified within Appendix A. The alternative requirements are subject to MBTA's Review and Approval and shall be in line with the intent and service proven history requirements of this Specification and provide an equivalent or superior performance to the specified requirements.

Appendix B – Definitions, Abbreviations, Standards and Trademarks

Appendix C – Track Maintenance and Safety Standards

Appendix D – Clearance Diagrams

1.4.2 Diagrams provided in Appendix D are currently in a "Draft" state. The Contractor shall meet the conditions of these diagrams, as outlined in Section 2.2. Approved diagrams will be provided at a later date

Appendix E – MBTA Existing Equipment and Drawings

1.4.3 Drawings include:

1.4.3.1 **Coupler Equipment**

1.4.3.1.1 Drawing No. 1001566 – Coupler Equipment to be provided for Blue Line Vehicle. Coupler will not include electrical heads and cables.

1.4.3.1.2 Drawing No. Q.51.18.005 – Coupler Equipment to be provided for Green Line Vehicle. Coupler will not include electrical heads and cables

1.4.3.2 **Wheel Profiles**

1.4.3.2.1 Drawing 49023 – Wheel - 28" RTL (Blue Line)

1.4.3.2.2 Drawing 47639 – Green Line Wheel Profile (Green Line)

1.4.3.3 **Door Key**

1.4.3.3.1 No drawing No. - MBTA Standard Door Key

Appendix F – Carbody and Truck Structural Analysis and Testing Requirements (If Applicable)

1.4.4 Appendix F is NOT applicable if a service proven or adapted from a service proven Truck and Carbody design is proposed. Appendix F is only applicable to brand new designs.

Appendix G – Track Charts

Appendix H – Book of Standard Trackwork Plans

1.4.5 Diagrams provided in Appendix H apply to MBTA's Rapid Transit Lines (RTL) and Light Rail Transit (LRT). The Blue Line is considered RTL and the Green Line is considered LRT.

2 SYSTEM DESIGN

This Section provides requirements for the features, functions, system performance, and the general design criteria for the OCS Inspection Car Consists.

2.1 DESIGN BASIS AND PARAMETERS

2.1.1 General Design Requirements

2.1.1.1 The Contractor shall provide OCS Inspection Car Consists with the ability to operate over the entire MBTA Green and Blue Lines.

2.1.1.2 The OCS Inspection Car Consists shall be designed for a minimum service life of 30 years, with 3,000 hours of annual average operating time at the worst case of the duty cycles specified in Section 2.5.9 and 2.5.10.

2.1.1.3 The Contractor shall provide a maintenance program for the MBTA to follow, that covers the specified service life of the vehicles, reference Section 15.3.2.2.

2.1.1.4 All human interfaces shall be designed in accordance with the requirements of MIL-STD-1472, SAE, UIC, or similar standards.

2.1.1.5 The Contractor shall submit a General Arrangement drawing that depicts the overall dimensions of the OCS Inspection Car Consists and equipment locations, including multiple views and perspectives for MBTA's Review and Approval. [CDRL 2.1.1.5]

2.1.2 Service Proven Design

2.1.2.1 The OCS Inspection Car Consists shall be based on service proven designs.

2.1.2.1.1 The MBTA defines service proven as designs to be implemented with systems or components that have demonstrated successful operation in a similar transit or railroad environment or that are evolved from such service proven designs.

2.1.2.2 The Contractor may also submit alternate proposals that utilize novel technology if they believe it provides a benefit with minimal risk to the MBTA.

2.1.2.2.1 Alternate proposals may be submitted during the Request for Proposal (RFP) phase. The MBTA will consider the alternate proposals during the evaluation process, request clarification if necessary, but approval and execution will be determined at the MBTA's sole discretion.

2.1.2.2.2 Alternate proposals may also be submitted after award, during the Design Review process, but shall be subject to MBTA's review and approval.

2.2 CAR DIMENSIONS AND CLEARANCE

2.2.1 The Contractor shall ensure that the OCS Inspection Car Consists are compliant with the MBTA clearance envelopes provided in Appendix D in all vehicle conditions and the dimensional requirements listed below. Note: The clearance envelopes are not the same as those for the MBTA Commuter lines and are more restrictive.

2.2.1.1 The carbody, wire maintenance lifts (stowed), and all roof-mounted equipment, including the inspection pantograph in the locked-down condition, shall provide a minimum of 6 inches clearance from the contact wire and all other OCS components under all conditions. Refer to Section 2.4.1 for allowable OCS dimensions.

2.2.1.2 Electrified third rail is used in some sections of the Blue Line. The carbody, underfloor equipment, and trucks shall provide a minimum of 3.5 inches lateral and 3 inches vertical clearance from the third rail under all conditions. Refer to Section 2.4.1 for third rail dimensions.

2.2.1.3 The carbody and underfloor equipment shall have a minimum clearance of 5.12 inches above top of rail (TOR) for all conditions.

2.2.1.4 Trucks and truck-mounted equipment, except wheels and trip cock arms, shall fit within the dynamic envelope in the drawings in Appendix D under all conditions.

2.2.2 The Contractor shall submit a clearance analysis for MBTA's review and approval , including the proposed static and dynamic clearance envelopes, vehicle swept path and truck dynamic clearance assessment for the OCS Inspection Car Consists, prior to carbody fabrication. [CDRL 2.2.2]

2.2.3 The Contractor shall perform a clearance test over all sections of the Green and Blue Line mainline track and areas of the yard with limited clearance. Refer to Section 14 Testing Program.

2.2.3.1 A clearance test plan shall be provided for MBTA's review and approval at least 30 days prior to the scheduled date of testing. [CDRL 2.2.3.1]

2.2.3.2 A clearance test report shall be provided to the MBTA no more than 15 days following testing, identifying any areas of limited clearance that might interfere with operation of the OCS Inspection Car Consists. [CDRL 2.2.3.2]

2.3 CAR LOADING AND WEIGHT

2.3.1 Each vehicle in the OCS Inspection Car Consist shall not exceed a gross vehicle weight of 100,000 lbs. and

2.3.2 Each axle of the OCS Inspection Car Consist shall not exceed 27,000 lbs.

2.3.3 The minimum wheelbase, truck center spacing, and end overhang for the OCS Inspection Car Consist shall be as shown in Figure 1.

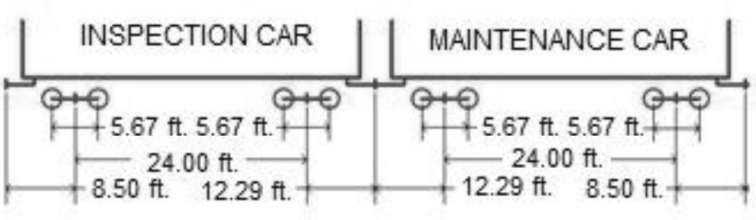

Figure 1: Minimum Wheelbase, Truck Center Spacing, and End Overhang in Feet

2.3.4 Equipment on the OCS Inspection Car Consists must be distributed such that the sum of the wheel loads on the right side of the car shall be within 5% of the sum of the wheel loads on the left side of the car.

2.3.5 The empty weight of each car in the OCS Inspection Car Consists shall be measured and recorded in the Car History Book. Refer to Section 16.7.

2.4 OPERATING ENVIRONMENT

2.4.1 Right of Way

2.4.1.1 Track charts of the Green and Blue Lines are provided in Appendix G. The MBTA's Track Maintenance and Safety Standards along with basic information of each line is provided in Appendix C. Track in yards is not maintained to these standards.

2.4.1.2 The table below provides basic information for the Green and Blue ROW.

	Green Line	Blue Line
Running Rail Nominal Gauge, Tangent Track	**4 ft 8-½ in.**	
Minimum Track Center Spacing	**9 ft 5 in.**	10 ft 2 in
Minimum Horizontal Curve Radius	**45 ft**	66 ft
Maximum super-elevation	**6.5 in.**	
Minimum Horizontal Reverse Curves	**47 ft Curve Radius** **10 ft Tangent** **52 ft Curve Radius**	400 ft Curve Radius 27 ft Tangent 400 ft Curve Radius
Maximum Grade	**8%**	5.1%
Minimum Vertical Curve Radius	**300 ft (Crest)** **400 ft (Sag)**	1000 ft (Crest) 2000 ft (Sag)
OCS Contact Wire Height (*Nominal*)	**12 ft 6 in. Min.** **19 ft 0 in. Max.**	13 ft 4.27 in. Min. 17 ft 0 in. Max.
OCS Inspection Car Consist Contact Wire Measurement Range (Refer to Section 2.4.1.2.2)	**12 ft 0 in. Min.** **19 ft 6 in. Max.**	

	Green Line	Blue Line
Contact Wire Type	**MBTA P-102, Rev. B 4/0 AWG Grooved Bronze Trolley Wire**	
Contact Wire Tension	**5,000 lbs. Max.**	
Messenger Cable Type	**MBTA P-178, Rev. 1 4/0 AWG Copperweld Stranded Messenger Wire**	
Messenger Cable Tension	**4,000 lbs. Nominal**	
Height of Third Rail above Running Rail	N/A	**5-7/16 in. Min. 6-7/16 in. Max.**
Horizontal Distance Running Rail (Gage Point) to Third Rail (Center)	N/A	**19-15/16 in. Min. 20-15/16 in. Max.**
Trip Cock Height Above Running Rail:	N/A	**2-3/8 in. Min. 2-5/8 in. Max.**
Horizontal Distance Running Rail (Gage Point) to Trip Cock (Center)	N/A	**7-3/4 in.**
Third Rail and OCS Voltage	**Direct Current 400V Min. 800V Max.**	

2.4.1.2.1 Trip cocks on the OCS Inspection Car Consists are only required on the consist to be delivered to the Blue Line. The trip cocks shall be positioned 36 inches from vehicle center.

2.4.1.2.2 Wire height listed is the nominal height and can drift outside of this range. The Contractor shall ensure that the OCS inspection Car Consists, OCS inspection systems, and related equipment can operate and measure to a minimum OCS wire height of 12 feet and maximum of 19 feet 6 inches. Refer to Section 11.3.2.1.

2.4.2 Anticipated Climate Conditions

2.4.2.1 The OCS Inspection Car Consists and all related equipment shall be capable of operating at all performance levels under the anticipated climate conditions listed in the table below.

Ambient Air Temperature	-20ºF (-28.9ºC) Min., 120ºF (48.9ºC) Max.
Relative Humidity	5% Min., 100% Max.
Maximum Rainfall Rate	4 in. per hour
Maximum Snowfall Rate	5 in. per hour
Maximum Snow Accumulation	18 in.
Maximum Wind Speed	40 mph (Sustained), 70 mph (Gusting)

2.4.2.2 Actual localized temperatures and conditions surrounding or within the carbody or equipment enclosures may be more severe than the ambient climatic conditions. The Contractor shall evaluate localized temperatures and conditions wherever necessary to ensure proper functioning of all equipment.

2.4.2.3 Under all conditions of wheel wear and suspension deflection, the OCS Inspection Car Consists shall operate in loose snow up to 12 inches (± 300 mm) above top of rail .

2.4.2.3.1 The OCS Inspection Car Consists shall withstand impacts with packed snow berms, such as those caused by road snowplows at grade crossings, without damage.

2.4.2.3.2 Specific loading conditions shall be determined by the Contractor and submitted for MBTA's review and approval. [CDRL 2.4.2.3.1]

2.5 OPERATING AND BRAKING PERFORMANCE

2.5.1 Except where otherwise required, the operating and braking performance shall be evaluated on level, tangent, dry track, in still air, over the allowable range of wheel wear, at the maximum gross vehicle weight.

2.5.2 Operating and braking performance calculations shall be submitted for MBTA's review and approval. [CDRL2.5.2]

2.5.3 Design Speeds

2.5.3.1 Design speed requirements are provided in the table below.

Maximum Operating Speed	40 mph
Maximum Safe Speed	45 mph

2.5.3.2 The OCS Inspection Car Consists shall be designed to operate continuously at the Maximum Operating Speed without damage.

2.5.3.3 Operation at the Maximum Safe Speed shall be possible but does not represent a normal operating condition.

2.5.4 Performance on Grade

2.5.4.1 The OCS Inspection Car Consists shall be able to accelerate from a stop up the steepest grade on the Green or Blue Lines with vehicles loaded to their gross weights.

2.5.4.2 The OCS Inspection Car Consists shall achieve the following speeds on the grades listed below:

Grade	Operating Speed
8%	5 mph
0.5%	40 mph

2.5.4.3 The OCS Inspection Car Consists at maximum gross weight shall be capable of stopping and starting up and down an 8% grade.

2.5.5 Brake Performance

2.5.5.1 Braking performance requirements are provided in the table below. The minimum safe brake rate shall be met for emergency braking under any single point failure condition.

Minimum Full Service Brake Rate	2 mphps
Minimum Emergency Brake Rate	3 mphps
Minimum Safe Brake Rate	1.47 mphps

2.5.5.2 The Contractor may propose blended dynamic/friction brakes or friction brakes only. However, the friction brakes shall be capable of providing the entire service and emergency braking effort in the event of a dynamic brake failure.

2.5.6 Jerk Limiting (If Applicable)

2.5.6.1 For electric drive transmissions, the system shall be able to control the instantaneous change of acceleration or deceleration (jerk) in order to minimize the impact on the crew and equipment.

2.5.6.1.1 The jerk limits shall be no more than 3.0 mphpsps.

2.5.6.1.2 The jerk limits specified shall apply to all normal power and service braking applications.

2.5.6.1.3 Emergency brake applications and spin/slide corrections shall not be jerk limited for either power removal or brake application.

2.5.7 Wheel Size Compensation (If Applicable)

2.5.7.1 For electric drive transmissions, a wheel size compensation system shall be provided to permit adjustment of tractive effort to maintain rated acceleration and dynamic braking performance over the entire range of wheel wear.

2.5.8 Parking Brake

2.5.8.1 Parking brakes shall hold the OCS Inspection Car Consists at maximum gross weight on an 8% grade indefinitely under all allowable wheel diameter and brake pad wear.

2.5.9 Brake/Propulsion System Duty Cycle

2.5.9.1 Duty cycle of the Brake/Propulsion systems shall be evaluated for the OCS Inspection Car Consists with all vehicles loaded to their maximum gross weight. Refer to Section 2.1.1.1.

2.5.9.1.1 The duty cycle shall include acceleration from zero speed to maximum operating speed and apply full service brake (friction brake only) back to zero speed, repeated for five cycles

without pausing between cycles, and be followed by acceleration to maximum operating speed and apply emergency brake back to zero speed.

2.5.9.1.2 If the OCS Inspection Car Consists contain dynamic braking, an additional duty cycle evaluation shall be completed with blended friction/dynamic brakes.

2.5.9.2 The duty cycle shall not cause any damage to the propulsion system, braking equipment, or wheels.

2.5.10 Work Shift Duty Cycle

2.5.10.1 The OCS Inspection Car Consists will be used for eight-hour work shifts. The Contractor shall provide multiple examples of possible duty cycles on battery operation including, but not limited to, 10 MPH operation with all systems functional.

2.6 ELECTRO-MAGNETIC COMPATIBILITY AND INTERFERENCE

2.6.1 The OCS Inspection Car Consists and their components shall not be adversely affected by any electro-magnetic frequency at field strengths found in the MBTA system.

2.6.2 The OCS Inspection Car Consists and their components shall not interfere with the transmission and the reception of the following established frequencies, as currently exist on the MBTA system in the following categories:

2.6.2.1 Signal power, Automatic equipment identification, Communication Equipment

2.6.3 Equipment design and enclosures shall shield equipment from any effects resulting from the operation of an MBTA handheld transceiver when it is within 18 inches of the enclosure.

2.6.4 Equipment design and enclosures shall shield equipment from any effects resulting from the operation of cellular telephones, including when telephones are operated within or nearby the vehicles.

2.6.5 Electromagnetic Compatibility

2.6.5.1 The OCS Inspection Car Consists shall be electromagnetically compatible within themselves, with all other rail vehicles and trains in operation at the MBTA, with the MBTA's signal system, with the MBTA's communications systems, with other electronic equipment, the MBTA's power system and the environment along the wayside.

2.6.5.2 **Electromagnetic Control and Test Plans**

2.6.5.2.1 The Contractor shall conduct a program which achieves and documents electromagnetic compatibility (EMC) of the OCS Inspection Car Consists in accordance with the APTA SS-E-010-98. [CDRL 2.6.5.2.1]

2.6.5.2.2 The Contractor shall apply the EMC program requirements to all subsystems and suppliers.

2.6.5.2.3 The Contractor shall ensure that all equipment, when operating individually or concurrently with other subsystems, complies with the EMC requirements.

2.6.5.2.4 The Contractor shall ensure that each OCS Inspection Car Consist configuration complies with the EMC requirements, in all possible operation modes, including all allowed modes of degraded performance and failure modes.

2.6.5.3 **Emission Limits**

2.6.5.3.1 The OCS Inspection Car Consists shall not exceed applicable portions of Title 47 CFR, MIL-STD-461A, and all critical limits identified in the EMC plan.

2.6.5.3.2 The radiated emission limits for OCS Inspection Car Consist shall not exceed the following values, measured 100 feet from the track centerline.

2.6.5.3.2.1 Emission limits are specified as dB microvolts per meter per Megahertz (dBµV/m/MHz) versus log frequency.

2.6.5.3.2.2 The term dBµV/m refers to electric field signal strength. The "/MHz" refers to the fact that the broadband signal shall be analyzed over 1 MHz bandwidths. Magnetic fields are typically limited to the same values, with the term dBµA/m. Only the electric field values are specified here.

Frequency, MHz	Radiated Limit at 100 ft (dBuV/m/MHz)
0.01	122
30	84
30	58
90	58
90	68
6000	68

2.7 NOISE, SHOCK, AND VIBRATION

2.7.1 Equipment mounted at any location on the carbody or trucks shall not cause objectionable or damaging vibrations or audible resonance anywhere on the vehicle floor, walls, ceiling panels, or seat frames, at any specified operating speed, under any acceleration or braking condition, except emergency braking.

2.7.2 Carbody, truck, and axle mounted equipment attachments shall be designed to withstand the exceptional and fatigue accelerations provided in the tables below.

2.7.2.1 The accelerations shall be applied independently, each combined with a vertical downward 1g acceleration from the weight of the equipment.

2.7.2.1.1 The exceptional and fatigue accelerations provided in the tables below are based on prior experience on the MBTA Green, and Blue Lines for passenger equipment. The Contractor shall be responsible for ensuring that these values are appropriate for the OCS Inspection Car Consists and proposing alternate values if necessary, for MBTA's review and approval.

Carbody Mounted Equipment			
Direction		**Exceptional Acceleration**	**Fatigue Acceleration 10 million cycles**
Longitudinal		± 3 g	± 0.15 g
Lateral		± 1 g	± 0.2 g
Vertical	At car ends At car center	± 2 g ± 0.5 g	± 0.25 g
Truck Mounted Equipment			
Direction		**Exceptional Acceleration**	**Fatigue Acceleration**
Longitudinal		± 5 g	± 2.5 g
Lateral	At axles centers At truck centers	± 10 g ± 5 g	± 5 g ± 2.5 g
Vertical	At axles centers At truck centers	± 20 g ± 10 g	± 6 g ± 3 g
Axle Mounted Equipment			
Direction		**Exceptional Acceleration**	**Fatigue Acceleration**
Longitudinal		± 10 g	± 5 g
Lateral		± 10 g	± 5 g
Vertical		± 70 g	± 25 g

2.7.3 Average noise levels in the vehicle interior with the doors closed shall not exceed the levels provided in the following table.

2.7.3.1 Noise levels shall be measured with all auxiliary equipment operating simultaneously.

2.7.3.2 Noise level measurements shall be taken in accordance with Appendix H to 49 CFR 229.

Vehicle Stationary: Engine Idling	75 dBA
Vehicle Stationary: Any Throttle Setting Except Idle	80 dBA
Vehicle Moving: Up to Maximum Operating Speed Any Propulsion or Braking Effort	85 dBA

2.7.4 Average noise levels emanating from the vehicle measured at a distance of 100 feet from the center of track and 4 feet above the top of rail shall not exceed the levels provided in the following table.

2.7.4.1 Noise levels shall be measured with all auxiliary equipment operating simultaneously.

Vehicle Stationary: Engine Idling	70 dBA
Vehicle Stationary: Any Throttle Setting Except Idle	82 dBA
Vehicle Moving: Up to Maximum Operating Speed Any Propulsion or Braking Effort	83 dBA

2.7.4.2 Any pure tone, where any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more, is prohibited per 310 CMR 7.10 and DAQC Policy 90-001.

3 CARBODY SYSTEM

This section provides requirements for the carbody system of the OCS Inspection Car Consists.

3.1 GENERAL

3.1.1 The Contractor shall ensure that the carbody is able to support all loads due to normal maintenance and operation of the OCS Inspection Car Consists, including material handling loads wire maintenance lift, wire handling device, wire reel operation, and dynamic loads imparted while traveling to and from the worksite.

3.1.2 The Carbody shall be constructed with safety, maintenance, and environmental features such as anti-climbers, safety appliances, anti-skid materials, IP rated enclosures, and lifting and jacking provisions.

3.2 SERVICE PROVEN DESIGN

3.2.1 The Contractor may submit an alternate compliance request in lieu of the requirements of this Section if they can demonstrate the proposed carbody assembly has a proven service history on a system with similar conditions to those of the MBTA. The alternate compliance request will be subject to MBTA's review and approval.

3.3 STRUCTURAL DESIGN LOADS

3.3.1 End Sill Compression Load

3.3.1.1 The carbody structure shall be capable of resisting a longitudinal end sill compression load of 200,000 lbs. applied at the center of the anti-climber over an area not exceeding the anti-climber height or 6 inches high, whichever is smaller, by 12 inches wide.

3.3.1.2 The end sill compression load shall be applied with the carbody loaded to the vehicle's maximum gross weight.

3.3.1.3 No permanent deformation or buckling of the carbody structure is permitted under the end sill compression load.

3.3.2 Coupler Anchor Loads

3.3.2.1 The carbody structure shall be capable of resisting a tensile (draft) coupler load and compressive (buff) coupler load of 200,000 lbs.

3.3.2.1.1 The coupler loads shall be applied to the drawbar or coupler anchor, longitudinally along the coupler centerline.

3.3.2.1.2 The loads shall be applied with the carbody loaded to the vehicle's maximum gross weight.

3.3.2.2 No permanent deformation or buckling of the carbody structure is permitted under the coupler loads.

3.3.3 Jacking and Hoisting Loads

3.3.3.1 No permanent deformation or buckling of the carbody structure or jacking pads is permitted under any of the following jacking/hoisting loads:

3.3.3.1.1 Vehicle loaded to maximum gross weight, including trucks, supported by the four jacking pads.

3.3.3.1.2 Vehicle loaded to maximum gross weight, including trucks, supported by the four jacking pads with two diagonally opposed jacking pads each carrying 40% of the vertical load and the remaining two jacking pads each carrying 10% of the vertical load.

3.3.3.1.3 Vehicle loaded to maximum gross weight, with one end of the car raised, supported by the end sill or coupler using a single jack or two-leg chain sling, and the other end of the car supported by the truck. The raised end of the car shall have the truck suspended from the carbody, with no contact between the wheels and the rail.

3.3.3.2 Each jacking pad shall be designed to support 40% of the vehicle's maximum gross weight, including trucks, combined with a horizontal load of 10% of the vertical load, applied in any direction.

3.3.4 End Impact Loads

3.3.4.1 The intent of this section is to minimize external obstacles from intruding into the crew area. Compliance with alternate standards such as EN/UIC may be proposed.

3.3.4.2 When a load of 15,000 lbs is applied perpendicular to the end wall structure of the operator and crew cabin, centered at approximately 1/3 the height of the cabin and at any location along the width of the cabin, and distributed over an area not exceeding 1/3 of the vehicle's overall width by 6 inches high, the stress at any location in the carbody structure shall not exceed the ultimate strength of the material.

3.3.5 Truck Connection Strength

3.3.5.1 The truck-to-carbody connection, as well as any intervening components, shall have sufficient strength to support a horizontal load of 150,000 lbs applied at any location on the truck frame in the direction of the center of truck rotation.

3.3.5.1.1 Under this load case, the ultimate strength shall not be exceeded in the truck-to-carbody connection, truck frame, carbody, or any intervening components.

3.3.5.1.2 The truck-to-carbody connection shall be able to support this load without failure while the trucks are at any possible vertical distance from the carbody, including the condition of the car raised off of the tracks with the truck hanging.

3.3.5.2 A positive mechanical connection shall be provided between the carbody and trucks, such that the trucks will be raised with the carbody unless the connection is intentionally disengaged for maintenance purposes.

3.3.5.2.1 The stress in the truck-to-carbody connection, truck frame, carbody, and any intervening components shall not exceed 50% of the yield strength with the complete weight of the truck hanging from the connection.

3.3.6 Natural Frequency

3.3.6.1 In order to minimize the likelihood of an induced oscillation, the Contractor shall demonstrate that the resonant frequency of the carbody at maximum gross weight, supported at the body bolsters is sufficiently separated from the resonant frequency of the truck suspension.

3.4 CARBODY FATIGUE LOADS

3.4.1 Loading

3.4.1.1 The carbody shall be capable of withstanding the anticipated fatigue loading for the design life of the for OCS Inspection Car Consist.

3.4.1.1.1 The fatigue load range for all carbody members and joints shall be determined by the Contractor but not be less than the stresses resulting from any combination of the following accelerations applied to the OCS Inspection Car Consist, while loaded to the maximum gross vehicle weight:

Longitudinally	± 0.15 g
Vertically	1.00 ± 0.25 g
Laterally	± 0.20 g

3.4.1.1.2 For the base material and each joint design, the computed stress range and mean stress shall be within the allowable fatigue endurance limits for non-redundant structures obtained from AAR C-II [M-1001] Section 7, AWS D1.1, or EN. Other industry standards may be proposed subject to MBTA's review and approval.

3.4.1.1.3 The Contractor may propose for MBTA's review and approval fatigue endurance limits based on testing performed by the Contractor.

3.4.1.1.4 All fatigue endurance limits shall be taken for 10 million cycles.

3.4.1.1.5 For the base material and each joint design, the maximum dynamic stress may not exceed the static yield strength.

3.4.2 Wire Maintenance Lift and Wire Handling Device Loading

3.4.2.1 The construction, attachment, and supporting structure for the wire maintenance lifts shall have sufficient strength to support all allowable loading conditions and maintenance lift positions, including mobile operation as defined in Section 12.1.10.

3.4.2.2 The construction, attachment, and supporting structure for the wire reels and all wire handling devices shall have sufficient strength to support all anticipated wire handling loads.

3.5 EQUIPMENT ATTACHMENT STRENGTH

3.5.1 The Contractor shall demonstrate through analysis and/or testing that the attachment of all carbody-mounted equipment weighing more than 150 lbs. is capable of withstanding the shock and vibration loads defined in Section 2.7.

3.5.1.1 All applicable equipment shall be identified in the Stress Analysis and Test Plan [CDRL 3.5.1.1]

3.5.1.2 Analysis and/or testing results shall be provided in an applicable report. [CDRL 3.5.1.2]

3.5.1.3 Analysis of equipment weighing less than 150 lbs. may be requested at the discretion of the MBTA.

3.5.2 If the operator and crew cabin is mechanically fastened to the underframe such that it does not form an integral part of the load-carrying structure, the shock and vibration loads defined in Section 2.7 shall be applied to the attachment of the cabin to the underframe.

3.6 CRASHWORTHINESS REQUIREMENTS

3.6.1 Anti-climbers

3.6.1.1 Anti-climbers shall be provided at both ends of the carbody extending the full width of the end sill with a height and profile that is compatible with the anti-climbers on the existing revenue vehicles. Due to the differences in anti-climbers, the MBTA assumes the anti-climbers will be bolt-on to allow for interoperability of the OCS Inspection Car Consists between the Blue and Green Lines.

	Anti-Climber Height (Center-to-TOR)	Anti-Climber Finger Spacing (Center-to-Center)	Number of Fingers
Green Line	27 in.	2.83 in.	3
Blue Line	38.54 in.	2 in.	3

3.6.1.2 The anti-climber structure shall resist without yielding a 75,000 lbf vertical load, applied in either direction, combined with a 125,000 lbf longitudinal compression load, applied at any location on the anti-climber.

3.6.1.2.1 Under these loading conditions, no yielding shall occur in the carbody structure or attachment of the anti-climber to the underframe.

3.6.1.2.2 Limited plastic deformation of the anti-climber fingers is acceptable, but ultimate failure of the anti-climbers shall not be permitted.

3.7 JACKING AND LIFTING PROVISIONS

3.7.1 Each vehicle within the OCS Inspection Car Consist shall be provided with lifting and jacking provisions.

3.7.2 The Contractor shall assume that portable electric car jacks will be used.

3.7.3 The Contractor shall coordinate with the MBTA the location of each lift and jack point to enable the following:

3.7.3.1 Proper maintenance at the MBTA's Green and Blue Line's existing maintenance facilities.

3.7.3.2 Lifting of the vehicles on and off the running rail.

3.7.3.3 Lifting of the vehicles from the end sill by means of a two-leg chain sling.

3.7.4 Clear access, unobstructed by equipment, shall be provided for all jacking pads and lifting locations.

3.7.5 All jacking pads shall be useable without damaging any part of the car or removing any equipment.

3.7.6 All jacking pads shall have a slip-resistant bottom surface.

3.7.7 All jacking pads shall be clearly labeled on the side of the car to identify their location.

3.8 CONSTRUCTION

3.8.1 Materials

3.8.1.1 All carbody materials shall conform to the Materials and Workmanship requirements of Appendix A. The Contractor may submit an alternate compliance request in lieu of the requirements of this appendix. Refer to Section 3.2.1 above.

3.8.1.2 The use of polyurethane insulation or asbestos is prohibited. See Appendix A for a complete of prohibited materials.

3.8.1.3 The roofs of all cabins and deck floor areas accessible to personnel shall be constructed so as to be electrically isolating.

3.8.2 Equipment Enclosures

3.8.2.1 All exterior equipment enclosures shall be sealed with an IP55 level of protection as defined by ANSI/IEC 60529, and constructed to NEMA 250, Type 4 or other industry standard subject to MBTA's review and approval.

3.8.2.1.1 Enclosures shall contain drain holes fitted with cotter pins or other approved drain clearing device.

3.8.2.2 Cooling air intakes shall be designed to prevent ingestion of snow, water, dust, and debris.

3.8.2.3 High velocity air exiting from any ventilation equipment shall be directed away from the track, tunnel ceiling, or roof, so as not to disturb snow, dirt, and debris.

3.8.3 Deck and Floor

3.8.3.1 The deck and cabin floor shall be smooth, flat, and level.

3.8.3.2 The deck shall be constructed with an MBTA approved anti-skid material to prevent MBTA personnel slips, skids, and falls.

3.8.3.3 The operator and crew cabin floor shall be constructed of an MBTA approved non-vermin supporting material that is not susceptible to rot, corrosion, or water absorption.

3.8.4 Watertight Construction

3.8.4.1 The carbody, including doors, windows, roof, and access panels, shall be watertight and not be subject to water leakage when operating at maximum speeds under extreme weather conditions as defined in Section 2.

3.8.4.2 Wire duct and conduit penetrations through the deck or floor shall extend above the deck or floor, or otherwise prevent water from entering the duct or conduit.

3.8.4.3 The design documentation shall demonstrate that water will not collect in open or closed structural sections. Sections should have drainage holes or be sealed with continuous welds.

3.8.5 Camber and Deflection

3.8.5.1 The carbody shall be constructed with sufficient positive camber such that the vehicle at maximum gross weight will not develop negative camber.

3.8.5.2 All equipment shall operate satisfactorily and not bind due to the carbody deflection caused by allowable variations of load.

3.8.6 Structural Connections

3.8.6.1 Carbody structural connections shall be of welded and/or riveted construction.

3.8.6.2 All welding shall be performed in accordance with AWS D1.1, D1.3, or EN15085. Other industry standards may be proposed subject to MBTA's review and approval.

3.8.6.2.1 Stresses in fatigue load cases shall not exceed the allowable stresses for the class of weld as specified by AWS standards and codes.

3.8.6.3 Rivets or bolts used in combination with welds in a connection shall not be considered as sharing the load with the welds.

3.8.6.3.1 When used in a connection, welds shall be designed to carry the entire load across the connection.

3.8.6.4 Refer to Appendix A for additional Materials and Workmanship requirements.

3.8.7 Mechanical Fasteners

3.8.7.1 All bolts supplied shall be minimum SAE J429 Grade 5, or metric equivalent, including markings.

3.8.7.2 All nuts shall be per SAE J995, or metric equivalent, and match or exceed the strength of the bolts.

3.8.7.3 All bolted connections shall be designed to the strength values of the hardware used with a factor of safety of 1.5 based on proof load of the bolt.

3.8.7.4 With the exception of attachment points for floor panels, interior panels and trim, there shall be no tapped holes in the carbody structure.

3.8.7.5 Wherever possible, equipment attachments shall transfer load using brackets bearing directly on the structural members to avoid bolts loaded in tension or shear.

3.8.7.6 Safety straps or hangers shall be used for all equipment mounted resiliently or using bolts loaded in tension or shear.

3.8.8 Painting and Corrosion Protection

3.8.8.1 A Carbody Painting and Corrosion Protection Plan shall be submitted for MBTA's review and approval, including, at a minimum, the following information. [CDRL 3.8.8.1]

3.8.8.1.1 Carbody painting scheme and colors, including underframe painting.

3.8.8.1.2 Location and text of warning labels (i.e. "Pinch Point", "Do Not Stand").

3.8.8.1.3 Location of vehicle number and number style.

3.8.8.1.4 Corrosion prevention for bolted/riveted connections, including those involving dissimilar metals.

3.8.8.1.5 Corrosion prevention for welded connections, including those involving dissimilar metals.

3.8.8.1.6 Sealant application to prevent water ingress.

3.8.8.1.7 Product information for all primer, paint, sealant, anti-seize, or related products used.

3.8.8.2 The vehicle's empty weight shall be stenciled or otherwise clearly displayed in a conspicuous location.

3.9 SAFETY APPLIANCES

3.9.1 Sill steps, hoop steps, side/end handholds, ladders, and railings shall be provided at both ends and on both sides of the vehicle as required to enable safe and convenient vehicle and lift operation, as well as access to inspection systems, equipment, and equipment storage locations.

3.9.1.1 Equipment storage locations shall be completely enclosed by removable or foldable railings having sufficient strength to retain the equipment being stored.

3.9.1.2 Safe and secure positions for transporting personnel shall be provided in accordance with 49 CFR 214.507.

3.9.2 Except as provided below, safety appliances shall be joined to the carbody structure by means of mechanical fasteners. Exceptions will require MBTA's review and approval.

3.9.3 The Contractor shall submit a vehicle layout showing the location and size of all safety appliances for MBTA's Review and Approval prior to beginning carbody fabrication. [CDRL 3.9.3]

3.10 ANALYSIS AND TESTING

3.10.1 Structural analysis and testing requirements are specified in Appendix F.

3.10.2 If the carbody proposed can be shown to be service proven in a similar application, existing documentation may be provided in lieu of the structural analysis and testing requirements shown in Appendix F. Refer to Section 3.2.1.

4 COUPLER SYSTEM

This section provides requirements for coupler equipment that will enable the OCS Inspection Car Consist to be towed by a revenue vehicle consist in the event of an OCS Inspection Car Consist failure.

4.1 COUPLER REQUIREMENTS

4.1.1 The MBTA will furnish / provide the Contractor with transit-style couplers and associated draft gear.

4.1.1.1 Drawings for the Blue and Green Line couplers to be provided by the MBTA can be found in Appendix E.

4.1.2 The Contractor shall be responsible for installing and integrating the provided coupler components into the OCS Inspection Car Consists.

4.1.3 Couplers shall be installed on both ends of every vehicle within the OCS Inspection Car Consist, enabling automatic mechanical coupling between OCS Inspection Car Consist vehicles, and towing of the OCS Inspection Car Consist with a revenue vehicle consist.

4.1.3.1 Pneumatic and electrical connections are not required between the OCS Inspection Car Consist and revenue vehicle consist when towing with a revenue vehicle consist.

4.1.4 Couplers shall be positioned on each line's OCS Inspection Car Consist at the following heights above top of rail:

4.1.4.1 Blue Line = 25.00 inches

4.1.4.2 Green Line = 16.00 inches

4.1.5 The OCS Inspection Car Consists shall be capable of negotiating the entire Blue and Green Lines, including the worst-case horizontal and vertical track curvature and superelevation on each line, while coupled to any Blue or Green Line revenue vehicle, under the worst-case conditions of wheel wear and suspension deflection, including suspension failure.

4.1.6 The draft gear and distance between the coupler face and anti-climber shall be coordinated such that opposing anti-climbers on coupled vehicles do not come into contact with the coupler loaded in buff up to the maximum load, but do come into contact when the couplers push back.

4.2 PNEUMATIC AND ELECTRICAL CONNECTIONS

4.2.1 Pneumatic connections shall be provided between vehicles in the OCS Inspection Car Consists.

4.2.1.1 Pneumatic connections may be integrated through the MBTA-provided couplers or through car-to-car hoses.

4.2.2 Manual cutout cocks shall be provided for each pneumatic connection.

4.2.3 Electric connections shall be provided via car-to-car jumpers designed, installed and integrated by the Contractor; electric coupler heads will not be provided by the MBTA.

5 OPERATOR STATIONS AND CREW CABIN

This section provides design information and requirements pertaining to the Operator Stations and Crew Cabin, including general arrangement, equipment and storage, operator's consoles, inspection equipment consoles, camera system, lighting, seating, and heating, ventilation, and cooling.

5.1 GENERAL REQUIREMENTS AND CONSTRUCTION

5.1.1 General

5.1.1.1 Operator Stations shall be provided as an enclosed area providing the operator a safe space to operate the OCS Inspection Car Consist.

5.1.1.2 Operator Stations shall be provided to enable safe movement of the OCS Inspection Car Consist in any direction at maximum operating speed.

5.1.1.2.1 The MBTA is interested in Operator Stations at both ends of the OCS Inspection Car Consist. Alternate arrangements that provide equivalent operator visibility may be proposed for MBTA's review and approval.

5.1.1.3 A Crew Cabin shall be provided as an enclosed utility area that includes lighting, electrical outlets, a workbench, space for tools and equipment, storage of limited materials, and if applicable seating for crew members.

5.1.1.4 Operator Stations and Crew Cabin areas may be arranged as a single or multiple enclosed spaces.

5.1.1.5 Operator Stations and Crew Cabin shall provide room to safely transport at least six crewmembers and one operator to and from worksites.

5.1.1.5.1 Not all crewmembers must be seated, but the MBTA is interested in seating for as many crewmembers as possible.

5.1.1.6 Heating, ventilation, and air conditioning shall be provided in and at all Operator Stations and Crew Cabin.

5.1.1.7 The OCS Inspection Car Consists shall be equipped with sufficient interior and exterior lighting to illuminate Operator Stations and Crew Cabin.

5.1.1.7.1 Lighting shall be arranged and have sufficient illumination to enable full operation of the OCS Inspection Car Consists and use of the Crew Cabin in all lighting conditions. Refer to Section 9.7 for additional lighting requirements.

5.1.1.8 Any pneumatic components mounted in the Operator Stations and Crew Cabin shall vent outside.

5.1.1.9 The OCS Inspection Car Consists shall be equipped with front view visible light and infrared (thermal) cameras for inspecting the ROW.

5.1.1.10 Operator Stations and Crew Cabin equipment shall be designed to withstand exposure to water or snow without damage in the event a window or door is open during inclement weather or car washing operations.

5.1.1.11 The layout of all Operator Stations and Crew Cabin shall provide an ergonomic fit for all personnel as defined by MIL-STD-1472, SAE, UIC or other similar standard.

5.1.1.12 An Operator Stations and Crew Cabin Arrangement and Construction plan shall be developed and submitted as part of the PDR package for MBTA's review and approval. [CDRL 5.1.1.11]

5.1.1.13 Other Operator Stations and Crew Cabin arrangements may be proposed that meet the intent or exceed the requirements of this Specification.

5.1.1.14 Vehicle number shall be stenciled in each operator station and crew cabin at a location easily visible to the operator or crew person.

5.1.2 Doors

5.1.2.1 Doors shall include a window in the upper half.

5.1.2.2 Doors shall be equipped with locking mechanisms that are compatible with the crew key defined in drawing VE-09-029-2, included in Appendix E.

5.1.2.3 Doors shall be arranged to unlock and open from inside the Operator Stations and Crew Cabin without a key.

5.1.2.4 Hold open devices shall be provided to hold the doors open.

5.1.2.5 Operator Stations and Crew Cabin shall have a means for an emergency exit through at least one opening in any vehicle orientation.

5.1.2.6 An emergency exit plan shall be provided as part of the PDR for MBTA's review and approval. [CDRL 5.1.2.5]

5.1.3 Interior Panels

5.1.3.1 Interior panels shall be installed, covering the sidewalls, end walls, and roof framing.

5.1.3.2 Non-hygroscopic insulation shall be installed between the interior panels and exterior sheathing, as required to meet the noise and vibration requirements of Section 2.7 and the environmental control requirements of this section and Section 2.

5.1.4 Windshield and Field of View

5.1.4.1 The operator's field of view from the operator stations shall be maximized to the extent possible, but no less than the following:

5.1.4.1.1 The vertically upward view shall be a minimum of 15 degrees, measured above the horizontal.

5.1.4.1.2 The vertically downward view shall permit detection of an object 24 inches high (measured from top-of-rail) placed 96 inches in front of the vehicle anti-climber.

5.1.4.1.3 The horizontal view shall be a minimum of 90 degrees about the forward line of sight.

5.1.4.2 Windshields shall be constructed to FRA type 1 requirements or an MBTA-approved equivalent.

5.1.4.3 Windshields shall include a means for window defrosting via electrically heated glass or alternative method approved by the MBTA.

5.1.5 Side Windows

5.1.5.1 Horizontal sliding side facing windows shall be provided, at a minimum, at each operator station on both sides of the car.

5.1.5.2 The sliding windows shall be large enough to allow operators to lean out and look down the side of the car.

5.1.5.2.1 Latches shall be provided on the window assembly to allow the window to be locked in multiple open positions.

5.1.5.3 The side windows shall be constructed to FRA type 2 requirements or an MBTA-approved equivalent.

5.1.5.4 All windows shall be sized as large as possible to provide unobstructed views for the operator and crewmembers.

5.2 CABIN EQUIPMENT

5.2.1 Operator Stations

5.2.1.1 Operator Stations shall be equipped with all controls, indicators, and communications equipment for travel operation of the OCS Inspection Car Consists.

5.2.1.2 Operator Stations shall be arranged to provide for full operation in the forward and reverse direction.

5.2.1.3 Switches and controls shall be of the industrial, heavy-duty type and designed to prevent inadvertent operation.

5.2.1.4 All controls and indicators shall be identified, preferably by engravings in the console panel or the indicator lenses.

5.2.1.5 Devices, such as air gauges and speedometer, shall be illuminated for daytime and nighttime operation without causing any reflections on the windshield and be controlled by a dimmer switch.

5.2.1.6 When one operator station's controls are activated, the other operator station's propulsion controls shall be locked out or inoperable.

5.2.1.7 Deadman system shall be provided and incorporated in the propulsion control such that if activated, it will deactivate propulsion, and activate the emergency brakes.

5.2.1.8 Emergency-stop (E-stop) buttons shall be provided at each operator station and lift controls (reference Section 12.8) that will shut down the OCS Inspection Car Consists, including all lifts and wire handling devices, and cause an emergency brake application.

5.2.1.8.1 The buttons shall be located to allow convenient access by the Operator as well as other crewmembers.

5.2.1.9 Audio and digital displays shall be provided to warn the Operator that the engine's electronic control system has detected a fault that affects the inspection, propulsion, auxiliary system operation (Ex. Putting the engine in degraded mode), or has shut down the engine because of overheating, overspeed, loss of fuel pressure, and/or loss of oil pressure.

5.2.1.10 Speedometers shall be provided and accurate within ±5% for all vehicle speeds, up to the maximum safe speed.

5.2.1.10.1 Speedometer shall provide the ability to recalibrate to compensate for wheel wear.

5.2.1.10.2 Speedometer function may be incorporated into an operator's display.

5.2.1.11 Hour meters shall be provided.

5.2.1.12 Fuel level indicators shall be provided.

5.2.1.13 A buzzer system shall be provided in all Operator stations, and at the wire maintenance lift controls, reference Section 12.8.

5.2.1.13.1 When the buzzer button is depressed, it shall activate the buzzer at all locations.

5.2.1.14 A horn or other audible warning device shall be provided at both ends of the OCS Inspection Car Consists in accordance with an audible output of 96 dBA at a distance of 100 feet.

5.2.1.14.1 Activation of the horn shall be provided within the Operator Stations.

5.2.1.15 Automatic vehicle change of direction alarms shall be provided in accordance with 49 CFR 214.511(b).

5.2.1.16 The Contractor shall submit layouts of the Operator Stations which describes placement and location of console panels, controls, switches, devices, indicators, deadman features, and alike for MBTA's review and approval. [CDRL 5.2.1.16]

5.2.1.17 Cushioned, adjustable operator seats shall be provided.

5.2.1.18 Adjustable sun visors shall be provided to allow the operator to limit sunlight coming through the windshield and adjacent side windows.

5.2.1.19 Rear facing mirrors and rear-facing cameras shall be provided to allow the operator to see the areas along the sides of the OCS Inspection Car Consists from a seated position.

5.2.1.19.1 The cameras shall be capable of operating (adjustable automatically) in low light and changing ambient light conditions.

5.2.1.20 Electrically operated windshield wiper or wipers shall be provided for each windshield.

5.2.1.21 Windshield washer systems shall be provided for each windshield.

5.2.2 Operators Stations and Crew Cabin

5.2.2.1 A safe and secure system of handholds and handrails shall be strategically placed to aid workers with interior travel.

5.2.2.2 A first aid kit that complies with 29 CFR 1926.50(d)(2) shall be provided at a readily-accessible location in the Operator Stations or Crew Cabin.

5.2.2.3 Coat hooks, preferably flush wall mounted, folding hooks, shall be provided in the Operator Stations and Crew Cabin.

5.2.2.4 Waste receptacles shall be provided in the Operator Stations and Crew Cabin.

5.2.2.5 Electrical convenience outlets shall be provided in the Operator Stations and Crew Cabins. Refer to Section 9 for additional requirements.

5.2.3 Crew Cabin

5.2.3.1 A sufficiently sized worktable suitable for standing work shall be provided in the Crew Cabin.

5.2.3.2 Shelving and storage compartments shall be provided in the Crew Cabin to provide storage of small parts, hand tools, hardware in a segmented fashion, and spare materials.

5.2.3.3 An MBTA furnished portable, multipurpose, dry chemical fire extinguisher shall be mounted in the Crew Cabin in an easily accessible location.

5.3 OPERATOR'S VIEW CAMERA SYSTEM

5.3.1 A front view camera system, designed for use in rail applications, shall be installed on the OCS Inspection Car Consists to provide a color view of the track and entire ROW.

5.3.1.1 The view may switch to grayscale in low-illumination conditions, if necessary, to provide sufficient clarity.

5.3.1.2 The MBTA intends the camera system to be used for inspection of the ROW. Clarity of the video shall allow for viewing all signs, markings, structures, components, and ROW equipment at any operating speed.

5.3.1.3 The camera system shall be capable of operating (adjustable automatically) in low light and no light (dark car) conditions, glare, and under rapidly changing ambient light conditions.

5.3.1.4 The camera system shall be installed on the end of the OCS Inspection Car Consists that is intended to be the primary forward direction.

5.3.2 A Digital Video Recorder (DVR) or computer with solid-state memory shall be provided and record the operator's view video.

5.3.2.1 Storage media shall have a minimum 12-hour continuous recording capability and the ability to download for off-site viewing.

5.3.3 All components of the camera system shall be commercially available in the event the system needs to be replaced or upgraded.

5.3.4 The proposed Operator's view camera system shall be provided for MBTA's review and approval. [CDRL 5.3.4]

5.4 THERMAL VIEW CAMERA SYSTEM

5.4.1 A single visual thermal inspection system shall be provided on the OCS Inspection Car Consists at the end that is intended to be the primary forward direction, facing outward, down the line of travel.

5.4.2 The thermal view camera system shall comprise of robust, thermal video cameras, memory, monitor, and all associated equipment.

5.4.2.1 The system may be integrated with the Operator's View Camera System in Section 5.3 above if both systems can be fully functional at the same time.

5.4.3 The system shall provide a view of the track and third rail to identify inoperative ROW heater systems.

5.4.4 A crew member shall have the ability to view the video feed in real time while in the Operator Stations or Crew Cabin.

5.4.4.1 Viewing of the video feed shall be completed by a crewmember other than the operator of the OCS Inspection Car Consist and not interfere with the movement and operation of the OCS Inspection Car Consist.

5.4.5 The camera shall be located in a location to allow for enough viewing of the ROW to determine location. In lieu of positioning the cameras to determine location, a GPS system may be used.

5.4.6 A Digital Video Recorder (DVR) or computer with solid-state memory shall be provided and record the thermal video.

5.4.6.1 The storage media shall have a minimum 12-hour continuous recording capability and the ability to download for off-site viewing.

5.4.7 The proposed thermal view camera system shall be provided for MBTA's review and approval. [CDRL 5.4.7]

5.5 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

5.5.1 The Operator Stations and Crew Cabin shall be equipped with a HVAC System or systems.

5.5.2 The HVAC system shall provide comfort for one Operator and six crew members, maintaining:

5.5.2.1 A temperature of at least 68° F with exterior temperatures down to 0° F

5.5.2.2 A temperature no more than 76° F for exterior temperatures up to 100° F

5.5.2.3 55% RH for all ambient conditions as specified in Section 2.

5.5.2.4 The Contractor may propose alternate temperature set points for when the OCS Inspection Car Consist is operating from the main battery, subject to MBTA's review and approval.

5.5.3 All components within the HVAC system shall be industry standard, service proven, and commercially available.

5.5.3.1 If an exception needs to be made, the Contractor shall provide the description of the exception to the MBTA for approval.

5.5.4 The system shall include a pressurized ventilation system that shall ensure a positive pressure in the Operator Stations and Crew Cabin areas with all doors and windows closed at all operational speeds as a means to prevent ingress of fumes and dust.

5.5.5 The HVAC unit shall be constructed to prevent high pressure water from the Car wash, rain or snow from entering the HVAC unit under any operating condition, or when the train is not in operation.

5.5.6 The HVAC System shall use R-407C or other MBTA-approved refrigerant having an ASHRAE safety and toxicity rating of A1.

6 PROPULSION SYSTEM

This section provides requirements for the propulsion system of the OCS Inspection Car Consists. The requirements of this section define a diesel/battery hybrid system.

6.1 SYSTEM CONFIGURATION

6.1.1 The OCS Inspection Car Consists shall have a diesel/battery hybrid propulsion system or alternative that meets the requirements and intent of this Specification.

6.1.1.1 The diesel engine shall be Tier 4 Final compliant with sufficient power to meet the duty cycle and performance requirements provided in Section 2 and this Specification.

6.1.1.2 The transmission shall be electric, hydrostatic, or other type proposed by the Contractor and approved by the MBTA.

6.1.1.3 The main battery shall provide sufficient current and capacity to power the OCS Inspection Car Consists for an eight-hour work shift in limited use work scenarios where use of the diesel power is not allowed.

6.1.2 Design documentation for the propulsion system shall be submitted for MBTA's review and approval, including but not limited to: propulsion system control, transmission configuration and efficiency; diesel engine performance, duty cycle, fuel consumption, and mounting configuration; engine starting, cooling, and preheating systems; exhaust routing; turbocharger and charge air cooler; fuel system; and emissions control. [CDRL 6.1.2]

6.2 CONTROL

6.2.1 General

6.2.1.1 The propulsion system shall provide self-protection against all normal irregularities to prevent damage to the engine or other propulsion system components.

6.2.1.2 The Electronic Control Unit (ECU) shall have a connector for a portable test equipment (PTE) that allows MBTA personnel to perform monitoring and diagnostic functions of the propulsion system during static testing and/or vehicle operations.

6.2.1.2.1 The Contractor shall provide PTE's as required by Section 17.3.2.

6.2.1.2.2 Access of the ECU by the MBTA personnel shall not invalidate the warranty.

6.2.2 Operating Modes

6.2.2.1 The Contractor shall submit a functional description of the various OCS Inspection Car Consist operating modes for MBTA's review and approval. [CDRL 6.2.2.1]

6.2.2.1.1 The functional description shall include details about the operation, as well as an overview of the state of each system and subsystem in each operating mode.

6.2.2.1.2 Controls for starting and stopping the diesel engine, including preheat, shall be described.

6.2.2.1.3 The Contractor shall propose whether diesel/battery selection occurs automatically or if a manual selection switch will be used.

6.2.3 Wheel Spin Control

6.2.3.1 The MBTA prefers the propulsion system be provided with a way to detect and correct wheel spin conditions in order to maximize acceleration performance and protect wheel treads and rails from damage.

6.2.3.2 The Contractor shall determine if Wheel Spin Control is needed to meet the performance requirements of the specification and their proposed OCS Inspection Car Consist.

6.2.4 Main Battery Management and Control

6.2.4.1 The system shall provide switching between diesel engine, main battery, and external layover power.

6.2.4.2 The main battery shall be configured to charge when power is available from the diesel engine generator or from an external source of layover power.

6.2.4.3 The battery shall be protected from overcurrent and undervoltage during charging or discharging.

6.2.4.4 Battery charge shall be monitored.

6.2.4.4.1 The battery charge level shall be clearly displayed for the operator.

6.2.4.4.2 A warning shall be provided to the operator when the main battery power is approaching 50%, 25%, and 10% capacity.

6.3 TRANSMISSION

6.3.1 Electric Drive

6.3.1.1 If electric drive transmission is provided, the Contractor shall propose a system architecture for MBTA's Review and Approval. [CDRL 6.3.1.1]

6.3.1.2 The system shall be configured so that no single-point transmission failure can disable propulsion on both trucks.

6.3.2 Hydrostatic Drive

6.3.2.1 If hydrostatic transmission (HST) is provided, the propulsion pumps shall be dedicated to the HST and not be used to power any other functions.

6.3.2.2 The hydraulic transmission shall be designed to prevent overpressure or engine overspeed.

6.3.2.3 Wherever feasible, the system shall use rigid stainless steel tubing for conveying hydraulic fluid.

6.3.2.3.1 Fittings and adaptors shall be of the O-ring type. Pipe threads are prohibited.

6.3.2.3.2 Fitting and adaptors shall be compliant with SAE.

6.3.2.3.2.1 Metric components shall not be used.

6.3.2.4 A hydraulic reservoir shall be provided with adequate capacity to prevent excessive heating and allow deaeration of the hydraulic fluid.

6.3.2.4.1 A cleanup access cover shall be provided to allow for the cleaning of the interior tank.

6.3.2.4.2 A drain hose with a lockable shut-off and threaded plug shall be provided and be routed to the side of the vehicle for ease of draining.

6.3.2.5 Quick connect pressure test ports shall be provided at key points in the system to assist in setup and troubleshooting.

6.4 DIESEL ENGINE FOR TRACTION POWER

6.4.1 General

6.4.1.1 Diesel engines shall have the following basic design features:

6.4.1.1.1 Self-protection, Low temperature starting capability, and EPA Tier 4 Final certified.

6.4.1.2 The engine shall be resiliently mounted to the sub frame and/or the sub frame resiliently mounted to the car.

6.4.1.2.1 Each diesel engine and associated close-coupled traction power equipment shall be mounted on a structural sub frame for modular removal from the car.

6.4.1.2.2 The mounting system shall withstand the shock and vibration criteria stated in Section 2.7 while minimizing noise and vibration transmitted to the vehicle.

6.4.1.3 Exhaust gases shall be released in a suitable location away from the HVAC or other equipment air intakes, operator stations and crew cabin, or other location where operators or personnel would be located during normal maintenance and operations.

6.4.1.4 To prevent agitation of accumulated dust, exhaust gases shall be directed away from the tunnel walls or ceiling as far as practical and/or diffused.

6.4.1.5 An independent battery system shall be provided for diesel engine starting and be sized for multiple starting attempts.

6.4.1.6 Radiators shall be accessible for cleaning without disassembling any equipment or removing any components and have connections for easy removal.

6.4.2 Maintainability

6.4.2.1 The diesel engines shall not require a major overhaul (engine disassembly) within fewer than 12,000 service hours when operating the OCS Inspection Car Consists according to the duty cycle requirements of Section 2.5.9 and 2.5.10.

6.4.2.2 Oil change shall not be necessary more often than every 500 service hours or 45 calendar days.

6.4.2.3 Diesel engine maintainability shall be demonstrated as part of the Maintenance Program and Maintainability Demonstration, reference Section 15.3.2.

6.4.3 Fuel System

6.4.3.1 The Contractor shall propose a fuel tank capacity based on their capabilities and experience.

6.4.3.2 The Contractor shall submit calculations supporting the fuel tank capacity for MBTA's review and approval. [CDRL 6.4.3.2]

6.4.3.2.1 The calculations shall show the expected number of work shifts between refueling based on the duty cycle requirements in Section 2.5.10.

6.4.3.3 Fuel tanks shall meet the crashworthiness requirements of 49 CFR 238.223 or an MBTA-approved alternative.

6.4.3.3.1 Fuel tanks that are existing designs and have a proven service history may forgo this requirement.

6.4.3.4 Fuel tank vent pipes shall not discharge on the roof nor on or between the rails.

6.4.3.5 Fuel tanks shall be electrically grounded.

6.4.3.6 Fuel tanks shall be fitted with internal baffles so as to minimize sloshing of the fuel under normal dynamic movement of the equipment.

6.4.3.7 An automatically controlled fuel heater shall be provided to keep fuel at an operationally acceptable temperature during cold weather operation, as defined in Section 2.4.1.2.1.

6.4.3.8 Two (2) fuel tank fill ports shall be provided, one on each side of the OCS Inspection Car Consists, accessible from the Right of Way next to the vehicle.

6.4.3.8.1 The fuel tank fill ports shall have adapters with integral strainers.

6.4.3.8.2 Analog fuel level gauges shall be provided adjacent to each fuel tank fill port.

6.4.3.8.3 Placards shall be placed in close proximity to the fuel tank fill ports identifying them as "Diesel Fuel Only".

6.4.3.9 An emergency fuel shut-off, located in close proximity to the fuel tank, shall be provided that has remote and manual actuation.

6.4.4 DEF System

6.4.4.1 If the system requires DEF, the tank shall have sufficient capacity to exceed the fuel refill cycle such that it is not necessary to refill the DEF more frequently than it is necessary to refill fuel.

6.4.4.2 The Contractor shall submit calculations supporting the DEF tank capacity for MBTA's Review and Approval. [CDRL 6.4.4.2]

6.4.4.3 Two (2) DEF fill ports shall be provided, one on each side of the OCS Inspection Car Consists, located near the fuel fill ports and accessible from the Right of Way.

6.4.4.4 The DEF fill ports shall have a 19 mm diameter opening with an internal flap that will prevent the use of other fueling nozzles that are not made for the DEF fueling application and a blue cap labeled "DEF only".

6.4.4.5 Placards shall be placed in close proximity to the DEF fill ports identifying them as DEF.

6.4.4.6 DEF shall be automatically kept at an operationally acceptable temperature during cold weather. Refer to Section 2.4.2 for environmental conditions.

6.4.5 Fire Detection System

6.4.5.1 A commercially-proven fire detection system shall be provided for the diesel engine.

6.4.5.1.1 Temperature sensors near the engine shall detect excessive heat levels.

6.4.5.1.2 If the trip level of the sensors is reached, the detection system shall visually and audibly warn the operator that a fire has been detected.

6.4.5.2 The need for an automatic fire suppression system shall be determined during the Fire Safety Analysis, reference Section 15.3.4.4.

6.5 MAIN BATTERY AND BATTERY ENCLOSURE

6.5.1 General

6.5.1.1 The OCS Inspection Car Consists shall be provided with a main battery that supplies the vehicle's systems when the diesel engine is shut down or unavailable.

6.5.1.2 The battery shall have capacity for one complete work shift, at the duty cycle defined in Section 2.5.10, with lifts, OCS inspection system, auxiliary systems, lights, controls, and limited propulsion.

6.5.1.2.1 The specified battery capacity shall be available under all environmental conditions identified in Section 2.4.1.2.1 for the entire service life of the battery.

6.5.1.2.2 The Contractor shall submit battery service life calculations for MBTA's review and approval.

6.5.1.2.3 The battery service life shall be no less than seven years.

6.5.1.3 On-Board equipment shall be included for charging the main battery via external layover power.

6.5.1.4 The Contractor shall coordinate layover power supply voltage, equipment, and locations with the MBTA.

6.5.1.5 The Contractor shall provide design documentation, sizing calculations, service life calculations, heat rise calculations, charging scheme, and other pertinent details of the main battery for MBTA's review and approval. [CDRL 6.5.1.5]

6.5.2 Battery Enclosure

6.5.2.1 The battery enclosure and battery casings shall be made of a corrosion-resistant material and be vented to the vehicle exterior.

6.5.2.2 If applicable, NiCd battery cells, trays, and enclosures shall be in accordance with the requirements of APTA-PR-E-RP-007-98 and IEEE Std 1536-2002. Other battery types may be proposed and subject to MBTA's review and approval.

6.5.3 Battery Cutout Switch

6.5.3.1 A battery disconnect switch or switches shall be provided that is compatible with standard lockout/tagout procedures.

6.5.3.2 The switch shall be of adequate capacity and mounted in an electrically insulated enclosure as close to the battery as possible.

6.5.3.3 The switch shall be readily accessible from the outside of the vehicle for quick removal of battery power.

6.5.3.4 The switch shall be configured to completely isolate the batteries.

6.6 TOWING PROVISIONS

6.6.1 Provisions shall be provided to allow the OCS Inspection Car Consists to be towed by a revenue vehicle without causing damage or excessive wear to any part of the propulsion system.

6.6.2 The Contractor shall submit details of the towing provisions, including a description of the steps necessary to safely tow the OCS Inspection Car Consists for MBTA's Review and Approval. [CDRL 6.6.2]

7 TRUCKS AND SUSPENSION SYSTEM

This section provides design and performance requirements for the trucks and suspension, including dynamic performance, hose and piping, and wheel, axle, and bearing requirements. The requirements in this section assume a dedicated rail vehicle with two-axle trucks.

7.1 GENERAL

7.1.1 Design

7.1.1.1 The trucks and components shall be a design or adaptation of a design meeting the service-proven requirements specified in Section 2.

7.1.1.1.1 The Contractor shall show in detail what has been changed from a service-proven design and why such changes will not adversely affect operation in the MBTA environment.

7.1.1.2 The design of the trucks shall adhere to APTA, AAR, or EN Standards, unless specifically approved by the MBTA.

7.1.1.2.1 The Contractor may propose and submit alternate standards or design guidelines for MBTA's review and approval.

7.1.1.2.2 Where differences between industry standards and the requirements of this Specification exist, the requirements of this Specification shall take precedence.

7.1.1.3 A design report for the truck assembly, suspension, and all related equipment shall be submitted for MBTA's Review and Approval. [CDRL 7.1.1.3]

7.1.1.4 Truck frames and components shall be identical and fully interchangeable between either end of the OCS Inspection Car Consists, without modification other than bolt on items.

7.1.1.4.1 It is understood drive trucks and idler trucks may be of differing designs.

7.1.1.4.2 All drive trucks shall be interchangeable with each other and all idler trucks be interchangeable with each other.

7.1.2 Pneumatic, Hydraulic, and Electrical Connections

7.1.2.1 All pneumatic, hydraulic, and electrical connections to the truck shall comply with the materials and workmanship requirements of Appendix A.

7.1.2.2 Hoses shall be used only where necessary to accommodate relative motion between components and to facilitate maintenance.

7.1.2.3 All other tubing and conduit shall be rigid.

7.1.3 Truck Serial Numbers

7.1.3.1 Each truck shall be provided with a permanently attached serial number plate located in a conspicuous place.

7.2 WHEELS, AXLES, AND JOURNAL BEARINGS

7.2.1 Wheels

7.2.1.1 Wheels shall be multiple-wear type of wrought steel, heat treated and shot peened per AAR M-107, Class B.

7.2.1.2 Wheels shall comply with the profile requirements provided in Appendix E.

7.2.1.2.1 The OCS Inspection Car Consist for the Blue Line shall comply with MBTA drawing 49023.

7.2.1.2.2 The OCS Inspection Car Consist for the Green Line shall comply with MBTA drawing 47639.

7.2.1.3 Wheels shall be supplied in sets of four with respect to tape size, the maximum allowable variation being ½ tape.

7.2.1.3.1 The tape size shall be stenciled with paint on each wheel in such a manner that this marking be legible after shipment.

7.2.1.4 Wheels shall be legibly identified as to serial number, manufacturer's symbol, date rolled, and date heat number.

7.2.1.5 The Contractor shall furnish copies of all reports required by AAR M-107.

7.2.1.5.1 Report copies shall be incorporated into the Car History Book for each car to the MBTA. Refer to Section 16.7.

7.2.2 Axles and Journal Bearings

7.2.2.1 Axles shall be made in accordance with AAR Specification M-101.

7.2.2.2 The Contractor shall submit a load diagram and static and dynamic stress calculations for the axles for MBTA's Review and Approval. [CDRL 7.2.2.2]

7.2.2.2.1 The Contractor shall consider loads imparted upon the axle by the wire maintenance lifts and wire handling devices in the axle stress calculations.

7.2.2.2.2 The Contractor shall consider the effect of the bending loads induced by the presence of restraining rails in the axle bending fatigue stress calculations.

7.2.2.2.3 Compliance with industry standard axle designs may be used without static and dynamic stress calculations with MBTA's approval.

7.2.2.3 The following inspections shall be performed on each axle:

7.2.2.3.1 Each axle shall be ultrasonically inspected in accordance with AAR Specification M-101-A.

7.2.2.3.2 Each axle shall be inspected by magnetic particle wet method after finishing.

7.2.2.3.3 Any axle which shows any sign of surface cracking shall not be accepted.

7.2.2.4 Each axle shall be permanently marked with the information required by AAR M-101.

7.2.2.5 The Contractor shall furnish copies of all reports required by AAR Specification M-101.

7.2.2.5.1 Reports shall be incorporated in the Car History Book for each car to the MBTA. Refer to Section 16.7.

7.2.2.6 Journal bearings shall be AAR approved type or European equivalent.

7.2.2.6.1 Other bearing types shall require MBTA's Review and Approval.

7.2.3 Pressing Requirements

7.2.3.1 Wheel-axle assemblies, including wheels, axles, journal bearings, gear hubs (if applicable), speed sensor gear rings (if applicable), ground brush rings, and brake disc hubs (if applicable), shall be assembled in accordance with the latest standard AAR practice.

7.2.3.1.1 Pressing charts shall meet the applicable requirements of AAR Manual of Standards and Recommended Practices Section G-II.

7.2.3.2 The wheel-axle assembly shall have a nominal wheel back-to-back measurement as follows:

7.2.3.2.1 Blue Line - 53-3/8 inches

7.2.3.2.2 Green Line – 54-3/16 inches.

7.2.3.3 Axles shall be rejected if they are galled or otherwise scarred during pressing.

7.2.3.3.1 In the absence of visible evidence of such galling or scarring, the use of pressing force in excess of that specified shall be taken as cause for rejection of the assembly.

7.2.3.4 Wheel, journal bearing seat, gear hub (if applicable), and brake disc hub (if applicable) pressing charts shall be submitted to the MBTA for each wheel-axle assembly as part of the Car History Book. Refer to Section 16.7.

7.2.4 Wheel Truing Provisions

7.2.4.1 Wheel truing shall be possible with trucks installed or not installed on a vehicle.

7.2.4.2 Wheel truing shall not require disassembly of any parts from the truck or the carbody, except the plugs or caps at the ends of the axle.

7.2.4.3 The interface between the wheels, trucks, carbody, and wheel truing equipment shall be submitted for MBTA's review and approval. [CDRL 7.2.4.3]

7.2.4.4 The Contractor shall evaluate whether wheel truing will be possible using the MBTA's existing in-ground and above-ground wheel truing equipment as-is at the Blue and Green Line maintenance facilities.

7.2.4.4.1 If wheel truing is not possible using some or all of MBTA's existing wheel truing equipment, the Contractor shall collaborate with MBTA to develop a plan for performing wheel truing throughout the design life of the OCS Inspection Car Consists.

7.2.4.4.2 The MBTA will provide any available wheel truing equipment information at the time of contract award.

7.2.4.4.3 The Contractor will be allowed to visit the MBTA facilities, after award, to view the existing equipment as needed to incorporate into their design and meet this Specification.

7.3 SUSPENSION

7.3.1 Suspension

7.3.1.1 The Contractor shall demonstrate that the resonant frequency of the suspension between the wheel-axle assembly and truck frame is sufficiently separated from the resonant frequency of the truck frame or any truck mounted equipment.

7.3.1.2 The suspension system shall include a positive mechanical connection between the journal bearings and trucks such that the journal bearings and wheel-axle assemblies will be raised with the truck without disengaging any part of the suspension system.

7.3.2 Dynamic Performance

7.3.2.1 The trucks shall be suitable for safe operation at speeds up to the maximum safe speed limit identified in Section 2 over the entire range of wheel and suspension component wear and car loading over the Green and Blue Line track.

7.3.2.1.1 If the proposed truck has a service history on similar systems, the Contractor may provide evidence of this in lieu of the following requirements.

7.3.2.2 The Contractor shall submit a dynamic analysis demonstrating the truck design track worthiness. [CDRL 7.3.2.2]

7.3.2.3 The qualification tests defined in APTA PR-M-RP-009-98 or an MBTA-approved industry standard shall be performed, as required by Section 14, and the test results submitted for MBTA's Review and Approval. [CDRL 7.3.2.3]

7.3.2.3.1 The truck shall equalize such that the raising or lowering of any one wheel in a truck by 2.0 inches will not cause the load on that or any other wheel to increase or decrease by more than 65 percent.

7.3.2.3.2 Raising or lowering any wheel on a truck up to 2.5 inches shall not result in loss of contact between that or any of the other three wheels and the rail.

7.3.2.3.3 For any portion of the proposed design which is based on a service-proven truck, the Contractor may provide data from previous tests to satisfy the corresponding portion of these requirements.

7.3.2.4 The vehicle-to-track Interaction Safety Limits in 49 CFR 213.345 for single wheel vertical load ratio, single wheel L/V ratio, net axle L/V ratio, truck side L/V Ratio, carbody lateral acceleration, carbody vertical acceleration, and truck lateral acceleration shall not be exceeded at any permitted speed, up to the maximum safe speed, under any combination of load and wheel friction conditions.

7.3.2.4.1 Data shall be obtained using instrumented track, instrumented wheel sets, and/or accelerometers as appropriate.

7.4 CONSTRUCTION

7.4.1 Materials

7.4.1.1 Truck frames and bolsters may be of cast or fabricated construction in accordance with the materials and workmanship requirements in Appendix A.

7.4.1.2 Where pockets or partially enclosed spaces exist, drainage shall be provided so that no moisture collects within the truck frame and bolster.

7.4.1.3 Threaded fasteners, adjustment points, and structurally critical locations shall be accessible for inspection and maintenance without special tools.

7.4.1.4 Trucks shall be painted in accordance with the materials and workmanship requirements in Appendix A.

7.4.2 Safety Hangers

7.4.2.1 Where applicable, traction motors and gearboxes shall be provided with safety hangars for support in the event of primary attachment failure.

7.4.2.2 Any resiliently-mounted truck equipment that could pose a derail hazard in the event of primary attachment failure, shall be provided with safety hangers.

7.4.2.3 The vehicle suspension shall be provided with approved safety devices to prevent hazardous operating conditions in the event of a failed bolt, shaft, or link.

7.5 SERVICE PROVEN DESIGN

7.5.1 If the truck proposed can be shown to be service proven in a similar application, documentation of this may be provided in lieu of the structural design, analysis, and testing requirements shown in Appendix F. Otherwise, the requirements of Appendix F apply.

7.6 SNOWPLOWS

7.6.1 Snowplows shall be provided to clear snow and deflect debris on the track and prevent such material from getting under the wheels.

7.6.1.1 Preferred configuration is to have snowplows mounted at the outboard ends of the end trucks so that they may be positioned as close to the top of rail as possible. However, carbody-

mounted snowplows and alternate structural requirements may be proposed for MBTA's Review and Approval.

7.6.2 The height of the plow above the top of rail shall be adjustable.

7.6.2.1 The adjustment range shall be sufficient to allow the plow to be set at nominal height under all conditions of wheel wear and manufacturing tolerances.

7.6.3 The snowplow shall be included as part of the truck frame structural analysis and the design submitted for MBTA's Review and Approval. [CDRL 7.6.3]

8 FRICTION BRAKE SYSTEM

The requirements of this section define a pneumatically actuated and controlled friction brake system for the OCS Inspection Car Consist.

8.1 GENERAL

8.1.1 The OCS Inspection Car Consists shall be equipped with a pneumatic friction brake system.

8.1.2 All pneumatic brake components shall be AAR-approved with spare parts and replacements readily available in the U.S. EN-based systems may be proposed if the supplier can ensure the availability of parts.

8.1.3 The brake apparatus shall be “safety-hung” and supported.

8.1.4 All electric terminals, studs, and air connections on each part of the pneumatic brake apparatus shall be clearly and permanently marked.

8.1.5 The friction brake system shall include individual brake cutouts for each car.

8.1.6 The brake cutout scheme shall be submitted for MBTA’s Review and Approval. [CDRL 8.1.6].

8.1.7 The Contractor shall submit a pneumatic brake system design and calculations at as part of the PDR package for MBTA’s Review and Approval. [CDRL 8.1.7]

8.2 FRICTION BRAKE PERFORMANCE

8.2.1 The Contractor shall identify and submit the method of meeting the minimum safe braking rate defined in Section 2 for MBTA’s Review and Approval. [CDRL 8.2.1]

8.2.2 An automatic pneumatic emergency brake shall be available after the system is charged.

8.2.2.1 The emergency brake shall be activated by any rapid reduction of brake pipe pressure such as when the automatic brake valve handle is placed in the emergency position, the emergency brake valve is actuated or upon the parting of the brake pipe or the brake pipe hose at any point in the train consist.

8.2.2.2 The brake system shall be designed to disengage propulsion when emergency brake is commanded.

8.2.3 The brake system shall include a deadman feature, designed to disengage propulsion and initiate emergency braking.

8.2.4 No single failure of the brake system shall result in a loss of more than 50% of the braking capacity.

8.3 PNUEMATIC BRAKE EQUIPMENT

8.3.1 Truck Mounted Brake Unit

8.3.1.1 Each truck shall be equipped with a truck mounted brake system.

8.3.1.2 The truck mounted brake system shall be designed to require minimum maintenance.

8.3.1.3 The brake system parts/components shall be readily accessible for performing maintenance and inspection.

8.3.1.4 The truck mounted brake system shall be designed to withstand the combined loads induced due to braking plus the effects of pressurization, with a margin of safety to accommodate a pressure regulation malfunction.

8.3.2 Brake Piping and Fittings

8.3.2.1 Brake piping and fittings shall be in accordance with the latest AAR standards for freight brake equipment.

8.3.2.2 Union fittings shall be provided in the brake piping, so that lengths of brake piping between tees may be replaced without disassembling or cutting the brake piping .

8.3.2.3 Any air piping on trucks shall be black pipe or other approved finish open hearth, extra heavy, welded steel pipe conforming to ASTM A53.

8.3.2.3.1 Use of stainless steel piping may be proposed subject to MBTA's Review and Approval.

8.3.2.4 All truck and air hose fittings shall be cast malleable iron conforming to ANSI B.16.3 with an approved finish.

8.3.2.5 Piping shall be free of imperfections such as burrs and sharp edges.

8.3.2.6 All piping shall be blown out with dry compressed air at the time of assembly.

8.3.2.7 Brake piping shall be adequately supported to withstand vibration encountered on the MBTA system with bolted clamps or other approved means.

8.3.2.8 All piping and fittings shall be arranged to ensure moisture drainage into reservoirs installed at the lowest points in the system.

8.3.3 Air Hoses

8.3.3.1 All flexible connections on the trucks, including those on the brake cylinders, between carbody and trucks, between truck and trip cock, and carbody and couplers shall be made with hoses.

8.3.3.2 All air hoses shall conform to AAR M-618, with AAR approved crimped fittings meeting AAR M-927.

8.3.3.2.1 Vulcanizing of any label to any hose is prohibited.

8.3.3.3 Air hose applications shall not be permitted in locations where adequate visual inspection cannot be made.

8.3.4 Cut-out Valves

8.3.4.1 All cutout valve handles, except for Brake Pipe angle valves, shall be arranged to be parallel with the pipe in the CLOSED position and perpendicular to the pipe in the OPEN position.

8.3.4.2 Cutout valves shall be oriented to a position that will not allow the valve handle to vibrate to the opposite position in service.

8.3.4.3 All cutout valves shall be identified with label and permanently marked with the direction of flow.

8.3.5 Reservoirs

8.3.5.1 Air reservoirs shall be drilled with "telltale" holes and shall be designed and manufactured to comply with requirements of 49 CFR 229.31(c), in lieu of periodic testing.

8.3.5.2 Each main reservoir shall be equipped with a heated, automatic/manual drain valve.

8.3.5.3 All reservoirs shall conform to the latest revision of Section VIII of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels.

8.3.5.4 Each pressure vessel shall be stamped to document the required testing.

8.3.6 Parking Brake

8.3.6.1 Each vehicle in the OCS Inspection Car Consist shall be equipped with a parking brake that provides sufficient braking force to hold itself, loaded to gross vehicle weight, on an 8% grade indefinitely.

8.3.6.2 The parking brake shall be controlled from the operator's location in the cab.

8.3.7 Air Compressor System

8.3.7.1 An air compressor shall be provided to supply air to the air brake system and any other auxiliary systems.

8.3.7.2 The inlet air filter shall be sized such that the replacement interval is greater than 92 days.

8.3.7.3 A regenerating-type air dryer, twin tower design with heated spitter valve shall be provided.

8.3.7.4 The dryer shall have adequate capacity to reduce the relative humidity of the compressed air to 35% at working pressure under all ambient conditions specified in Section 2.4.1.2.1.

8.3.7.5 A vented cutout cock shall be provided on the pneumatic line between the air compressor and the main reservoir tank.

8.3.7.5.1 The vent of the cutout cock shall be on the air compressor side and allow for isolation of the air compressor from the pneumatic system.

8.3.8 Snow Brake

8.3.8.1 An operator-controlled snow brake shall be provided that applies the friction brake and tread cleaning pad (if applicable) at appropriate pressures to prevent icing without damaging any friction brake components or wheel treads.

8.3.9 Deadman

8.3.9.1 The brake system shall be configured to interface with deadman feature specified in Section 5.2.1.7 to initiate an emergency brake application.

8.3.9.2 The Contractor shall submit the deadman configuration for MBTA's Review and Approval. [CDRL 8.3.9.2]

8.3.10 Trip Cocks

8.3.10.1 Four (4) trip cocks, one on each end and on each side, shall be installed on the OCS Inspection Car Consist intended for operation on the Blue Line.

8.3.10.2 Trip cocks shall be truck-mounted and located such that the lever will positively engage the track trip arm, reference Section 2.4.1 for location.

8.3.10.3 The trip cocks shall be mounted such that their height above top of rail can be adjusted in increments of 0.25 inch or less to maintain the appropriate height over the full range of allowable wheel wear.

8.3.10.4 Activation of a trip cock shall result in an emergency brake application.

8.3.10.4.1 The trip cock shall be self-resetting after activation.

8.3.10.4.2 WABCO D-1 valves or an MBTA-approved equal shall be used.

8.3.10.5 An individual cutout shall be provided for each trip cock.

8.3.10.6 Trip cocks are not used on the Green Line, but all piping and fittings that comply with the clearance requirements shall be installed on both OCS Inspection Car Consists to support interoperability.

8.3.11 Sanding System

8.3.11.1 A sanding system shall be provided that deposits sand immediately in front of the leading wheels of the lead truck on the OCS Inspection Car Consists.

8.3.11.1.1 Sand distribution shall depend on the driving direction.

8.3.11.2 The sanding units shall be pneumatically operated and be heated to keep the sand dry.

8.3.11.3 The sand flow rate shall be adjustable.

8.3.11.4 If wheel spin control is provided, the sanding system shall provide automatic application when a wheel spin is detected.

8.3.11.5 Manual control of the sanding system shall be possible via a push button located on the Operator Stations.

9 ELECTRICAL SYSTEM

This section provides design and performance requirements for the electrical system, lighting and the Monitoring and Diagnostic System.

9.1 ELECTRICAL SYSTEM CONFIGURATION

9.1.1 The electrical system shall be configured such that main power is provided by the generator or main battery in normal operation.

9.1.2 A backup power source for emergency operation shall be provided in the event main power is lost. Refer to Section 9.3 below.

9.1.3 The Contractor shall submit the design scheme of the electrical system for MBTA's review and approval. [CDRL 9.1.3]

9.2 POWER SUPPLIES

9.2.1 Power supplies shall comply with IEC 61287-1, IEC 60571, and IEEE Std 1476-2000. Compliance to alternate standards may be proposed for MBTA's Review and Approval.

9.2.2 Multiple voltages, as dictated by the Contractors design shall be provided on the OCS Inspection Car Consists.

9.2.3 The MBTA expects, at a minimum, the following voltages shall be provided:

9.2.3.1 480V ± 5%, 60Hz ±1%, Three Phase

9.2.3.2 120V ± 5%, 60Hz ±1%, Single Phase

9.2.3.3 24V ± 4V Direct Current

9.2.3.4 12V ± 2V Direct Current

9.2.4 All vehicle control circuitry, emergency lighting, signals and communications shall be 24V DC or 12V DC.

9.2.5 Circuit protection shall be provided to protect power supply components, prevent overcharge of the battery, and limit the battery charging current.

9.2.6 Battery charging shall be temperature compensated.

9.2.7 Load analyses shall be in tabulation format per Appendix A in IEEE Std 1476-2000 or other MBTA approved format.

9.2.8 Load management shall be provided for load application and shedding under emergency conditions (refer to section 9.3).

9.2.8.1 Load management details shall be provided during the design review process for MBTA's review and approval. [Include in CDRL 9.1.3]

9.2.9 PTE connection to the power supplies shall be provided and accessible to maintenance personnel.

9.3 BACKUP POWER

9.3.1 Critical loads and functions shall be automatically transferred to the backup power supply in the event of a loss of main power.

9.3.1.1 Power to all critical loads and functions shall not be interrupted during transition to the backup power supply.

9.3.2 The backup power, at a minimum, shall be sized to provide power to the following loads, for two hours with associated duty cycles:

9.3.2.1 All work equipment and lifts (to stored positions); (refer to Section 12.10.3)

9.3.2.2 Interior and exterior emergency lighting (continuous);

9.3.2.3 Exterior marker lights and visual warning devices (continuous);

9.3.2.4 Communications (continuous);

9.3.2.5 Event recorder (continuous);

9.3.2.6 OCS Inspection System (to save and safely shut down the system);

9.3.2.7 All Consist controls (continuous).

9.3.3 The Contractor shall supply a backup power supply sizing analysis that demonstrates that the backup power supply capacity is sufficient to meet these requirements. [Include in CDRL 9.1.3]

9.4 CONVENIENCE OUTLETS

9.4.1 Duplex convenience outlets shall be installed for 120 VAC, 60 Hz, 20 A service.

9.4.2 Outlets shall be provided at a minimum in the following locations:

9.4.2.1 Each Operator's Station, Crew Cabin (minimum of two), and each side of the car (on the exterior).

9.4.3 Exterior outlets shall be weatherproof and suited for the intended operation.

9.4.4 Convenience outlet covers shall be marked "120 VAC".

9.4.5 The Contractor shall submit the design scheme for the convenience outlets for MBTA's review and approval. [Include in CDRL 9.1.3]

9.5 CIRCUIT PROTECTION

9.5.1 Each circuit shall be protected by circuit breakers to protect the wiring and load devices.

9.5.2 All 120 VAC convenience outlets shall be provided with tamper resistant, weather resistant, ground fault circuit interrupters and galvanic isolation.

9.5.3 All equipment shall be protected against damage and malfunction by transient voltages.

9.5.4 Equipment that can generate electrical transients shall include suppression devices to reduce transient voltages to an acceptable level.

9.5.5 A lightning arrestor rating shall be selected to prevent voltage transients and surges from damaging or degrading carborne equipment.

9.6 CARBODY AND EQUIPMENT GROUNDING

9.6.1 The carbody structure shall not be used as a normal circuit return path for any electrical equipment.

9.6.2 All equipment on the OCS Inspection Car Consists, including resiliently mounted equipment, enclosures, the truck frame, and truck-mounted equipment, shall be safety grounded to the car structure, unless technically justified by the Contractor and approved by the MBTA.

9.6.3 The grounding system shall be designed to eliminate the potential for electric spark erosion to bearings that may be subject to this exposure.

9.6.4 The Contractor shall submit design schemes for the grounding system for MBTA's review and approval. [Include in CDRL 9.1.3]

9.7 LIGHTING

9.7.1 General

9.7.1.1 All exterior lighting shall be waterproof with an ingress protection (IP) rating suitable for the operating environment.

9.7.1.2 All lighting fixtures shall be designed to provide ease of installation and maintenance.

9.7.1.3 Light emitting diode (LED) lighting shall be used throughout the car.

9.7.1.3.1 Use of fluorescent lighting is not permitted.

9.7.1.4 Lighting arrangement, illumination characteristics, and control configuration shall be submitted for MBTA's review and approval. [CDRL 9.7.1.4]

9.7.2 Interior Lighting

9.7.2.1 The average illumination throughout the operator stations and crew cabin at an elevation of 33 to 66 in above the floor shall be a minimum of 30 lumens per square foot.

9.7.2.2 The lighting scheme shall be designed to minimize glare that may be reflected off the operator's windshield.

9.7.3 Console Lighting

9.7.3.1 Dimmable lighting shall provide illumination for all controls located in the operator stations.

9.7.4 Headlights

9.7.4.1 Two aimable headlights shall be provided on each end of the OCS Inspection Car Consists.

9.7.4.1.1 The headlights shall meet the requirements of SAE J1383.

9.7.4.1.2 Headlight controls shall have settings for Off, Dim, or Bright.

9.7.5 Tail Lights

9.7.5.1 Two red tail lights shall be provided on each end of the OCS Inspection Car Consists.

9.7.5.1.1 The tail lights shall be plainly visible from a distance of not less than 500 ft. (152 m) during daylight, bright sunny conditions.

9.7.5.1.2 The tail lights shall meet the requirements of SAE J2040.

9.7.5.1.3 The tail lights on the end of the consist opposite the direction of motion shall be illuminated when in forward or reverse.

9.7.5.1.4 The tail lights on both ends of the consist shall be illuminated when in neutral.

9.7.6 Stop Lights

9.7.6.1 Two red stop lights shall be provided on each end of the OCS Inspection Car Consists.

9.7.6.1.1 The stop light function may be provided by increasing the brightness of the tail lights or by a separate light fixture.

9.7.6.1.2 When illuminated, the stop lights shall be plainly visible from a distance of not less than 500 ft. (152 m) during daylight, bright sunny conditions.

9.7.6.1.3 The stoplights shall meet the requirements of SAE J2261.

9.7.7 Turn Signal Lights

9.7.7.1 Two amber turn signal lights shall be provided on each end and each side of the OCS Inspection Car Consists.

9.7.7.1.1 When illuminated, the turn signal lights shall be plainly visible from a distance of not less than 500 ft. (152 m) during daylight, bright sunny conditions.

9.7.7.1.2 End turn signals shall meet the requirements of SAE J2261.

9.7.7.1.3 Side Turn Signals shall meet the requirements of SAE J2039.

9.7.7.2 Hazard light functionality shall be provided.

9.7.8 Marker Lights

9.7.8.1 Two red and two green marker lights shall be provided on each end of the OCS Inspection Car Consists.

9.7.8.1.1 The marker lights shall be positioned near the upper corners of the OCS Inspection Car Consists.

9.7.8.1.2 When illuminated, the marker lights shall be plainly visible from a distance of not less than 500 ft. (152 m) during daylight, bright sunny conditions.

9.7.8.1.3 Marker lights shall meet the requirements of SAE J2042.

9.7.8.1.4 Red marker lights shall be illuminated at both ends of the OCS Inspection Car Consists when in standby or operate mode and vehicle in neutral.

9.7.8.1.5 Green marker lights shall be illuminated on the leading end and red marker lights on the trailing end of the OCS Inspection Car Consists, relative to the direction of travel, when in operate mode with the vehicle in forward or reverse mode.

9.7.9 Walkway and Ladder Lights

9.7.9.1 Walkways and ladders on the OCS Inspection Car Consists shall be illuminated to allow safe passage of personnel.

9.7.10 Reflectors

9.7.10.1 Reflectors shall be provided on each of the OCS Inspection Car Consists in compliance with 49 CFR 224.

9.7.11 Work Lights

9.7.11.1 The OCS Inspection Car Consists shall be equipped with Work lights that are adjustable for personnel to direct the lighting as needed.

9.7.11.2 Work lights shall be controlled by on/off switches at the operator stations, at the OCS inspection system controls, or at the upper wire maintenance lift controls as applicable. Reference Sections 11.2.2 and 12.8.

9.7.11.3 Lighting shall not be blocked by personnel or equipment located on the vehicle deck to the extent practicable.

9.7.11.4 Lights shall be provided to illuminate the following areas at a minimum:

9.7.11.4.1 The deck/storage area of the OCS Inspection Car Consists.

9.7.11.4.2 Inside engine and other equipment enclosures that require maintenance access.

9.7.11.4.3 Undercar equipment (where necessary).

9.7.11.4.4 The Right of Way on both sides of the OCS Inspection Car Consists.

9.7.11.4.5 Overhead Contact system as required by the task being completed.

9.7.11.4.6 Work platforms (locations dependent on design).

9.7.12 Visual Warning Lights

9.7.12.1 An operative intermittent warning light or beacon shall be mounted in such a way that it is visible 360-degrees around the OCS Inspection Car Consists to track workers. Multiple lights may be needed to accomplish this requirement.

9.8 MONITORING DIAGNOSTIC SYSTEM (MDS)

9.8.1 General

9.8.1.1 A microprocessor-based MDS shall be provided to assist MBTA personnel in monitoring, inspecting, maintaining, troubleshooting, and testing the major OCS Inspection Car Consist systems.

9.8.1.2 The MDS shall gather, process, and record high-level parameters for each system being monitored and communicate events and failures to an Operator Display within the Operator Stations.

9.8.1.3 The systems monitored by the MDS shall include, but not be limited to, the diesel engine, the propulsion system, friction brake system, and electrical system.

9.8.1.4 Accessing and downloading recorded data, and modifying MDS parameters, shall be accomplished via Contractor-provided PTE that can be connected to the MDS.

9.8.1.5 The communication interface between each system and the MDS shall be based on fast network protocol such as Ethernet, or an MBTA-approved equal.

9.8.1.6 The Contractor shall submit an MDS system plan detailing the system functional description, user interfaces, system interfaces, materials, and hardware. [CDRL 9.8.1.6]

9.8.1.6.1 The plan shall also include a detailed breakdown of the hierarchy of screens to be displayed for faults and maintenance troubleshooting.

9.8.2 Physical Requirements

9.8.2.1 The MDS shall have sufficient memory capacity to save all necessary data between periodic maintenance.

9.8.2.2 The memory capacity shall be sized to prevent overwrites during this period.

9.8.2.3 The MDS shall use solid-state memory.

10 COMMUNICATIONS AND EVENT RECORDER SYSTEM

This section provides requirements for the communications system, including PA system, intercom and train radio, and event recorder.

10.1 GENERAL

10.1.1 The OCS Inspection Car Consists shall be provided with an intercom system, a public address (PA) system, event recorder, and provisions for the MBTA to install a radio system.

10.1.2 The Contractor shall identify a location at the Operator Stations for future installation of an MBTA radio system.

10.1.2.1 Provisions shall be made to provide power to this location(s).

10.1.3 A functional description for the communications and event recorder system that are described in this section shall be submitted for MBTA's review and approval. [CDRL 10.1.3]

10.2 INTERCOM

10.2.1 The intercom system shall be a two-way audio design scheme to allow operators and crew members to communicate between operator stations, crew cabin, and wire maintenance lifts, independent of the MBTA radio system.

10.3 PA SYSTEM

10.3.1 The public announcement (PA) system shall be a one-way audio design scheme to communicate with personnel or pedestrians through the use of loudspeakers.

10.3.2 The loudspeakers shall be strategically located where the announcements can be heard 360 degrees from the vehicle, at a minimum, above background noise levels of 85 dBA at 100ft.

10.3.3 Loudspeakers shall be designed to operate in the MBTA's environment.

10.4 EVENT RECORDER

10.4.1 The event recorder shall be a self-contained unit with data storage and retrievable capabilities that do not require removal of the event recorder.

10.4.1.1 Example suppliers are Wabtec and Progress Rail.

10.4.1.2 Use of vehicle PLC operating system typically will not meet this requirement.

10.4.2 At a minimum, the event recorder shall record the following information:

10.4.2.1 Date and Time, Vehicle Speed, Distance Traveled, Propulsion/ Brake commands, Operator Station Status, Horn Activation, Wire Maintenance Lift commands, and Wire Handling Device commands.

10.4.2.2 The Contractor may propose alternative and additional information.

10.4.3 The event recorder shall be waterproof, tamper-resistant, and comply with the requirements of IEEE 1482.1 and 49 CFR 229.135 or other MBTA-approved industry standard.

10.4.4 Design documentation of the event recorder and associated equipment shall be provided to the MBTA for approval. [Include in CDRL 10.1.3]

10.5 TRAIN RADIO

10.5.1 Provisions shall be made to install an MBTA radio at the operator's station(s).

10.5.2 The MBTA radio may include a Radio head Unit, power supply, antenna, and microphone for communicating with OCC.

10.5.3 Specific information, including size, power requirements, and technical specifications for the MBTA Radio's will be provided after contract award.

10.6 AUTOMATIC VEHICLE IDENTIFICATION (AVI) SYSTEM

10.6.1 Provisions shall be made to install an MBTA supplied AVI system on the Green Line OCS Inspection Car Consist only.

10.6.2 The MBTA AVI system may include a power supply, encoder, and transponder.

10.6.3 Specific information, including size, power requirements, and technical specifications for the MBTA AVI system will be provided after contract award.

11 OCS WIRE INSPECTION SYSTEM

This section provides requirements for the OCS wire inspection system. The purpose of the inspection system is to assist maintenance personnel with their routine inspections by monitoring and detecting irregularities in the OCS.

11.1 GENERAL

11.1.1 The OCS Inspection Car Consist shall be equipped with an OCS inspection and measuring system, also known as the "inspection system", that has the ability to take measurements and record, store, analyze, and transmit all measured data.

11.1.2 The inspection system shall have the ability to perform the following measurements and functions of the OCS:

11.1.2.1 Wire height measurements from top of rail.

11.1.2.2 Wire stagger measurements from superelevated track center line.

11.1.2.3 Compensation for carbody movement relative to top of rail and center of track.

11.1.2.4 Wire wear measurement.

11.1.2.5 Impact measurement and detection to identify irregularities in the wire or wire supports.

11.1.2.5.1 The impact detection system requires a contact-type system; however, contact or non-contact systems may be proposed for all other measurements.

11.1.2.6 Thermal imaging to identify areas of high resistance or current draw.

11.1.2.7 Visual imaging to identify asset condition and location.

11.1.2.8 Record location for all data points, including above and below grade locations.

11.1.2.9 Analyze recorded data and identify trends in measurements over time to establish maintenance needs.

11.1.2.10 Define different acceptance criteria at multiple track locations.

11.1.2.11 Generate alarms for measurements outside of MBTA-defined acceptance criteria.

11.1.2.12 Display all measurements in real time with an on-board workstation.

11.1.3 The inspection system shall be of a service proven design and commercially available.

11.1.4 The inspection system shall have full functionality in all lighting conditions above ground and below ground with no degradation in performance.

11.1.5 The inspection system shall function under all environmental and right of way conditions, reference Section 2.

11.1.6 The Contractor shall develop an inspection system design and integration plan to be submitted for MBTA's review and approval. [CDRL 11.1.6]

11.1.7 The inspection system design and integration plan, at a minimum, shall describe the following:

11.1.7.1 Type of system and components to be utilized.

11.1.7.2 General layout of all equipment, including components of the on-board workstation.

11.1.7.3 User interfaces and software programs.

11.1.7.4 Ranges of measurement, accuracy, precision, and resolution.

11.2 INSPECTION EQUIPMENT

11.2.1 Inspection Pantograph

11.2.1.1 An inspection pantograph shall be provided.

11.2.1.1.1 The inspection pantograph is not required to have the capabilities of collecting current and shall be electrically insulated from the carbody.

11.2.1.1.2 The inspection pantograph shall include two replaceable contact strips to prevent wear of the contact wire.

11.2.1.2 The nominal length across the end-horns of the inspection pantograph shall be 47 inches.

11.2.1.3 The length of the contact strip shall be at least 31 inches.

11.2.1.4 The contact strip outside-to-outside spacing shall not exceed 13.09 inches.

11.2.1.5 The inspection pantograph shall be able to operate at any height within the contact wire measurement range. Reference Section 2.4.1.2.

11.2.1.5.1 No portion of the inspection pantograph shall be lower than the insulator top plane when the pantograph height is within the contact wire measurement range.

11.2.1.6 The inspection pantograph shall comply with the clearance requirements of Section 2.2 in the locked-down position.

11.2.1.7 The contact strip of the inspection pantograph shall be the highest point on the pantograph from lockdown to the maximum operating height.

11.2.1.8 The inspection pantograph for the OCS Inspection Car Consist on the Blue Line shall be mounted over the truck's center of rotation.

11.2.1.9 The inspection pantograph for the OCS Inspection Car Consist on the Green Line shall be mounted such that it follows the same path as a Green Line Type 9 pantograph on curved track.

11.2.1.9.1 The OCS Inspection Car Consist on the Green Line shall have the ability to move the inspection pantograph to a position over the truck's center of rotation.

11.2.1.10 The Contractor shall submit an analysis of inspection pantograph tracking for MBTA's review and approval prior to carbody fabrication. [CDRL 11.2.1.10]

11.2.1.11 Controls for automatically raising and lowering the pantograph shall be provided with the OCS inspection system.

11.2.1.12 Manual pull-down and release shall be provided for the inspection pantograph in the event of primary raising or lowering system failure.

11.2.1.12.1 The manual pull-down and release shall be electrically insulated.

11.2.1.13 The inspection pantograph shall raise automatically and provide a shoe force on the contact wire that is adjustable between 14 to 28 lbs under static conditions.

11.2.1.13.1 The shoe force shall be initially set to 18 lbs ± 1lb.

11.2.2 Inspection Console

11.2.2.1 An inspection console shall be provided inside the cabin to operate the inspection system.

11.2.2.2 The inspection console shall be an ergonomic design and include a work table, operator's seat, viewing monitors, and inspection system controls.

11.2.2.3 The inspection console shall be located within the cabin to allow for a second person to view the monitors while the inspection console is occupied.

11.2.2.4 The inspection console shall allow the operator to start and stop measurements, turn inspection lighting systems on and off, select displays, input inspection notes, manually flag locations, and other features agreed upon by the Contractor and the MBTA.

11.2.2.5 The inspection console shall be provided with selectable displays that show real time measurements, allow access to recorded data, control analysis software and tools, or other related equipment for full function of the system.

11.2.3 Inspection Lighting

11.2.3.1 Adequate lighting shall be installed to assist the visual inspection system when operating in areas of low to no lighting.

11.2.3.2 The lights shall be of LED type.

11.2.3.3 The lights shall not interfere with the thermal imaging system.

11.2.3.4 The lights shall be adjustable to direct lighting to areas requiring inspection.

11.2.3.4.1 At a minimum, lights shall be provided facing forwards, backwards, and directly upwards.

11.3 MEASUREMENT SYSTEMS

11.3.1 Impact Detection

11.3.1.1 The inspection system shall be equipped with a means to detect and measure irregularities in the OCS.

11.3.1.1.1 The MBTA envisions impacts to be measured using accelerometers. Other measurement techniques may be proposed, subject to MBTA's review and approval.

11.3.1.2 The accelerations of the inspection pantograph head shall be measured in all three axes.

11.3.1.3 The Contractor shall determine the necessary accuracy and precision of the impact detection devices, subject to MBTA's review and approval.

11.3.1.4 The inspection system shall flag problem locations based on MBTA-defined and adjustable acceptance criteria.

11.3.1.4.1 Out-of-tolerance measurements shall be audibly and visually annunciated at the workstation.

11.3.1.4.2 The ability to edit the acceptance criteria shall be password protected.

11.3.2 Wire Wear, Stagger, and Height Measurements

11.3.2.1 The inspection system shall be capable of measuring the following:

11.3.2.1.1 Wire wear - as a percentage of wire thickness.

11.3.2.1.2 Wire stagger - within ± 24 inches from center of track.

11.3.2.1.3 Wire height - over the entire measurement range. Reference Section 2.4.1.2.

11.3.2.2 The inspection system shall compensate for carbody movement in order to provide wire height and stagger measurements relative to the actual top of rail and center of track.

11.3.2.2.1 MBTA prefers a compensation system that can also provide track geometry measurements including gauge, curvature, horizontal alignment, superelevation, cross-level, twist, and vertical profile.

11.3.2.3 The inspection system shall utilize location-based acceptance criteria for wire height and stagger.

11.3.2.3.1 The inspection system shall have the ability to define the following acceptance criteria for every location:

11.3.2.3.1.1 Maximum height

11.3.2.3.1.2 Minimum and maximum stagger at maximum height

11.3.2.3.1.3 Minimum height

11.3.2.3.1.4 Minimum and maximum stagger at minimum height

11.3.2.3.2 An audible and visual notification at the workstation shall be provided when measurements are beyond the acceptance criteria.

11.3.2.3.3 The inspection system shall provide MBTA with the ability to edit the acceptance criteria and the locations where the acceptance criteria apply.

11.3.2.3.3.1 Editing the acceptance criteria shall be password protected.

11.3.2.3.4 The inspection system shall report measurements and provide trending even if acceptance criteria are not defined.

11.3.2.4 The Contractor shall propose the accuracy and precision of the wire wear, stagger, and height measurements based on their capabilities and experience, subject to MBTA's review and approval.

11.3.3 Thermal Imaging

11.3.3.1 The inspection system shall be equipped with a thermal imaging system to detect hot spots in the OCS.

11.3.3.2 The Contractor shall propose the accuracy, precision, and resolution of the thermal imaging system based on their capabilities and experience, subject to MBTA's review and approval.

11.3.3.3 The thermal imaging system shall have the capability to have adjustable parameters to achieve the proper image.

11.3.4 Visual Inspection

11.3.4.1 The visual inspection system shall be commercially available off the shelf.

11.3.4.2 The visual inspection system shall be capable of recording, storing, and playing back data.

11.3.4.3 Visual inspection cameras shall be capable of operating at the MBTA service speeds and lighting conditions.

11.3.4.4 The Contractor shall propose the resolution of the visual inspection system based on their capabilities and experience, subject to MBTA's review and approval.

11.3.5 Location

11.3.5.1 All measurement data recorded by the OCS inspection system shall be tagged with location.

11.3.5.2 Location shall be measured using a system that provides sufficient accuracy both above and below ground.

11.3.5.3 Location shall be recorded in terms of the stationing on the track charts in Appendix G.

11.3.5.3.1 The MBTA anticipates that a combination of GPS, dead reckoning, and/or wayside locator tags will be used to meet this requirement.

11.3.5.3.2 Alternate configurations may be submitted for MBTA's review and approval.

11.3.5.4 The OCS inspection system shall determine, either automatically or based on user input, the track designation and direction of travel.

11.3.5.4.1 The track designation must include the branch, if applicable, as well as the track designation (e.g. B-EB).

11.3.5.5 The Contractor shall propose the accuracy and precision of the location measurements based on their capabilities and experience, subject to MBTA's review and approval.

11.3.5.6 The Contractor shall work in conjunction with the MBTA to develop a method for tracking location.

11.4 SOFTWARE AND DATA STORAGE

11.4.1 Software

11.4.1.1 Software used to operate the inspection system and analyze recorded data shall be user friendly and of an existing service proven design.

11.4.1.2 Data recorded by the inspection system shall have the following format:

11.4.1.2.1 Date in the form of Month/Day/Year, time in the 12 hour system am / pm, location in terms of station number and track, and direction of travel.

11.4.2 Storage Capacity

11.4.2.1 The Contractor shall develop and submit an Inspection System data storage, retention, and transfer plan for MBTA's review and approval. [CDRL 11.4.2.1]

11.4.2.1.1 The Inspection System shall use solid-state memory.

11.4.2.2 The inspection system shall be equipped with enough memory to record and store inspection runs for at least 300 miles (10 round trips of the longest route on the MBTA's operating line).

11.4.2.3 The inspection system shall have the ability to transfer data to a remote server via Wi-Fi or to a workstation or PC using removable memory such as a flash drive.

11.4.2.4 The Contractor shall identify any equipment, such as data servers, that are required to provide full system functionality and long-term data retention.

12 WIRE MAINTENANCE LIFTS AND WIRE REELS

This section provides requirements for wire maintenance lifts, wire handling devices, and wire reels for the purpose of OCS inspection, maintenance, and wire replacement. Alternate arrangements may be proposed that meet the intent of this Specification. The Contractor will be afforded the opportunity to witness the existing operation after award to refine their design to meet the needs of this Specification.

12.1 GENERAL

12.1.1 Electrically insulated vertical and bucket personnel lifts, also known as “wire maintenance lifts” or “lifts”, shall be installed on the OCS Inspection Car Consists to provide access to the OCS.

12.1.1.1 Alternate arrangements may be proposed that meet the intent of this Specification.

12.1.2 The OCS Inspection Car Consists shall be equipped with wire handling devices.

12.1.3 The OCS Inspection Car Consists shall allow for the storage and use of two wire reels.

12.1.4 The lifts and all associated components shall be in complete conformance with ANSI/SAIA A92.2-2015 and all applicable requirements of 29 CFR 1910 and 29 CFR 1926.

12.1.5 The lifts shall allow for working on the live, electrically energized, OCS in full compliance with all OSHA and other applicable federal or state regulations.

12.1.6 The lifts shall be designed for storage outside and have the ability to withstand associated environmental and UV exposure.

12.1.7 Instructions for the operation, inspection, and maintenance of the lifts, including inspection and testing of the lift electrical insulation, shall be provided as part of the operations and maintenance manuals.

12.1.8 Training on the operation, inspection, and maintenance of the lifts, including inspection and testing of the lift electrical insulation, shall be provided as part of the training program.

12.1.9 The Contractor shall submit all lift configuration information as part of the Preliminary Design Review Package. [CDRL 12.1.9]

12.1.10 Both lifts shall be configured for mobile operation such that the OCS Inspection Car Consists can be moved with the lifts loaded to their maximum capacities and raised/extended without causing damage to the lifts or carbody structure under all conditions of braking, acceleration, and vehicle dynamics.

12.1.10.1 The Contractor may propose, for MBTA’s review and approval, lift position and speed restrictions for mobile operations.

12.1.11 Both lifts shall be interlocked with the propulsion system to prevent the OCS Inspection Car Consists from:

12.1.11.1 Moving with either lift in a position that is not allowable for mobile operation,

12.1.11.2 Overspeed during mobile operation of the lifts, and

12.1.11.3 Moving the lifts into an unsafe position while the OCS Inspection Car Consists are in motion.

12.1.11.4 Reference ANSI/SAIA A92.2-2015 for definition of mobile operation.

12.2 LIFT CLEARANCE

12.2.1 The lifts, when stowed, shall comply with the clearance requirements in Section 2.2.

12.2.2 The vertical lift shall be able to elevate completely without fouling the adjacent track, under static conditions, at any location on the Blue or Green Line.

12.2.3 The vertical lift shall be able to elevate to the maximum allowable position for mobile operation without fouling the adjacent track, under dynamic conditions, at any location on the Blue or Green Line.

12.2.4 The minimum permitted spacing between the lift and the dynamic clearance envelope of a passing revenue vehicle shall be 6 inches.

12.2.5 The operations manual shall clearly list conditions that will result in the lifts fouling the adjacent track or extending outside of the dynamic clearance envelope.

12.3 VERTICAL LIFT

12.3.1 The vertical lift shall have sufficient capacity for four people simultaneously working on the OCS.

12.3.2 The vertical lift platform shall have guardrails and kickplates.

12.3.3 The vertical lift platform surface shall be covered with an anti-slip material.

12.3.3.1 The anti-slip material may not interfere with inspection and testing of the lift electrical insulation.

12.3.4 The vertical lift platform height in the raised position shall be, at a minimum, 20 feet above top of rail.

12.3.5 The vertical lift platform shall be able to rotate a minimum of 90° in both directions about the vertical axis.

12.3.6 The vertical lift platform shall be able to extend the overall platform length.

12.3.6.1 The intent of this requirement is to maximize the lateral reach of the vertical lift platform. The Contractor shall propose the maximum lift extension based on their capabilities and experience. [CDRL 12.3.6.1]

12.3.6.2 Translation of the platform may be proposed in place of platform extension.

12.3.7 Storage bins for hand tools and small equipment shall be provided on the lift platform, outside of the guardrail.

12.3.7.1 Storage bins shall be of sufficient size to hold runners used for OCS section breaks (cutouts).

12.3.7.2 Storage bins shall be designed to minimize swinging or accidental unhooking.

12.3.7.3 Storage bins shall be configured to meet the lift clearance requirements.

12.4 BUCKET LIFT

12.4.1 The bucket lift shall be electrically insulated (reference Section 12.10.2), articulating, boom-style lift, with the capacity for one person.

12.4.2 The bucket lift shall be configured to allow access to the messenger wire, cantilevers, head spans, or other components located above the contact wire or on the OCS poles.

12.4.3 The bucket lift shall be capable of movement in all directions, including rotation about the vertical axis.

12.4.3.1 The boom shall rotate about the vertical axis a minimum of 200 degrees in both directions.

12.4.4 The bucket shall have sufficient adjustability to keep the bucket level at any allowable boom position.

12.4.5 The bucket lift shall be capable of providing access to the following locations while simultaneously maintaining sufficient clearance from the contact wire:

12.4.5.1 Immediately above the contact wire, at least 25 feet above top of rail.

12.4.5.2 At a distance of 25 feet from center of track, at least 31 feet above top of rail.

12.4.5.3 At a distance of 33 feet from center of track, at least 22 feet above top of rail.

12.4.6 Storage bins for hand tools and small equipment shall be provided outside of the bucket.

12.4.6.1 Storage bins shall be of sufficient size to hold runners used for OCS section breaks (cutouts).

12.4.6.2 Storage bins shall be designed to minimize swinging or accidental unhooking.

12.4.6.3 Storage bins shall be configured to meet the lift clearance requirements.

12.5 WIRE HANDLING DEVICES

12.5.1 The vertical and bucket lifts shall have a vertically-oriented, electrically insulated positioning arm to aid with lateral positioning of the contact wire or messenger wire.

12.5.1.1 Attachment points for wire-positioning pulleys or come-alongs shall be provided on the positioning arm.

12.5.1.2 Positioning arm electrical insulation shall prevent line voltage from being applied to the lift platform and meet the requirements of Section 12.10.2.

12.5.2 An electrically insulated roller shall be provided for vertical positioning of the contact wire or messenger wire.

12.5.2.1 The roller shall be mounted to the vertical lift platform or to an elevating arm that can be raised and lowered independently from the lift.

12.5.2.2 If the roller is mounted to the lift platform, it shall be possible to manually adjust the height of the roller relative to the lift platform.

12.5.2.3 If the roller is mounted to an elevating arm, it shall be possible to control the height of the arm from the upper or lower lift controls.

12.5.2.4 The roller shall positively retain the contact wire to prevent a slacked wire from slipping off of the roller.

12.5.2.4.1 Manual disengagement of the wire retention device shall be possible to allow for setting up or completing work.

12.5.2.5 The roller shall be configured to feed the contact or messenger wire around any horizontal curve on the Green or Blue Lines.

12.5.2.6 If provided, the elevating arm shall have an equivalent electrical insulation rating to the lift, reference Section 12.10.2.

12.5.2.7 The roller or roller attachment shall prevent line voltage from being applied to the lift platform or elevating arm and meet the requirements of Section 12.10.2.

12.5.3 All wire handling devices, their mounting attachments, and supporting structures shall have sufficient load-carrying capacity to support the load of the contact or messenger wire under the worst-case conditions.

12.5.4 The Contractor shall submit configuration details, electrical insulation ratings, and strength analyses for all wire handling devices. [CDRL 12.5.4]

12.6 LIFT STRENGTH AND STABILITY

12.6.1 Lifting Capacity

12.1.1.1 The maximum capacity of the lifts shall be based on the specified quantity of personnel and all allowable tools and equipment, assuming a weight of 350 lbs. per person.

12.1.1.2 All structural and stability analyses shall be performed with the lifts loaded to their maximum capacities.

12.6.2 Loading Conditions

12.6.2.1 The lift systems, attachments, and supporting structure shall be capable of supporting the loads defined by Section 4.2 of ANSI/SAIA A92.2-2015 and the following loads with the lifts loaded to their maximum capacities.

12.6.2.1.1 The loads shall be applied with the OCS Inspection Car Consists at any location along the track and under any environmental conditions, including wind and snow/ice.

12.6.2.1.2 Wire handling loads, including loads due to wire installation or due to positioning the fully-tensioned contact or messenger wire, applied with the lifts at any allowable position for mobile or stationary operation, as applicable.

12.6.2.1.3 Shock and vibration loads, as defined in Section 2.7, with the lifts at any allowable position for mobile operation.

12.6.2.1.4 Loads due to braking and acceleration, as defined in Section 2.7, with the lifts at any allowable position for mobile operation.

12.6.2.2 The Contractor shall determine the appropriate phasing of loads to assess the static and fatigue strength of the lifting systems.

12.6.2.2.1 The loads or stresses may not exceed the allowable limits provided by Section 4.2 of ANSI/SAIA A92.2-2015.

12.6.2.3 The lift platform guardrail strength shall comply with the requirements of ANSI/SAIA A92.2-2015, Section 4.9.1 with a 500 lbf load applied to each rail.

12.6.2.4 The Contractor shall submit a strength analysis report for the lift platform/bucket, lifting device, attachment, and supporting structure for MBTA's review and approval. [CDRL 12.6.2.4]

12.6.3 Stability

12.6.3.1 The lift system and OCS Inspection Car Consists shall meet the stability requirements provided in Section 4.5 of ANSI/SAIA A92.2-2015 on the worst-case Green or Blue Line superelevation, reference Section 2.4.1.2, instead of a 5° slope.

12.6.3.2 The Contractor may propose suspension lockout, downriggers, or outriggers if necessary, for stationary operation of the bucket lift.

12.6.3.3 The Contractor shall submit a lift stability analysis for MBTA's review and approval. [CDRL 12.6.3.3]

12.7 WORK LIGHTING

12.7.1 Lights shall be provided on the lift platform/bucket to illuminate the lift platform/bucket, OCS, and the surrounding area.

12.7.1.1 The direction of lighting shall be adjustable by personnel in the lift platform/bucket.

12.8 OPERATING CONTROLS

12.8.1 Upper and lower controls shall meet the requirements of ANSI/SAIA A92.2-2015.

12.8.1.1 Upper controls for the wire maintenance lifts shall be located either inside or immediately outside of the lift guardrail or bucket.

12.8.1.2 Lower controls for the wire maintenance lifts shall be located at the operator station in a position with a clear line of sight to the lift platform or bucket at any allowable position.

12.8.2 Upper and lower controls shall include lift height, rotation, extension, and lighting.

12.8.3 Upper and lower controls shall include a slope indicator.

12.8.4 The upper lift controls shall include emergency-stop buttons as described in Section 5.2.1.8.

12.8.5 The upper lift controls shall include a buzzer and intercom providing communication with the operator stations, reference Section 5.2.1.13.

12.8.6 The lower lift control shall include an emergency override of the upper lift controls.

12.8.7 The lifting controls shall not allow movement of the lift into an unsafe condition.

12.8.8 The lifts shall have variable speed control.

12.8.9 The lift controls shall be designed for use by personnel wearing insulating gloves.

12.8.10 The Contractor shall submit lifting control configuration details and control schematics for MBTA's review and approval. [CDRL 12.8.10]

12.9 WIRE REEL

12.9.1 The OCS Inspection Car Consists shall be equipped to carry and utilize two (2) wire reels for contact or messenger wire replacement activities.

12.9.1.1 The MBTA wire reels can range from diameters of 46-60 inches and widths of 26-40 inches.

12.9.2 The wire reels shall be housed within electrically insulated, environmentally-protected enclosures.

12.9.2.1 The wire reel enclosures shall have provisions for locking using heavy-duty padlocks.

12.9.2.2 The wire reel enclosures shall include electrically insulated wire rollers as needed for safe wire handling.

12.9.3 The wire reel mountings and enclosures shall be electrically insulated in accordance with the dielectric strength requirements of Section 12.10.2.

12.9.4 The wire reels, mountings, and supporting carbody structure shall have sufficient strength to withstand the shock and vibration loads defined in Section 2.7, for the heaviest wire reel.

12.9.5 The wire reels, mountings, and supporting carbody structure shall be capable of withstanding the contact or messenger wire breaking strength without permanent deformation.

12.9.6 An adjustable brake shall be provided for each reel to maintain control of the wire during unspooling.

12.9.6.1 The adjustable brakes shall have a free spooling mode.

12.9.7 The wire reel enclosures shall allow for wire reels to be loaded and unloaded using a fork truck from the side of the OCS Inspection Car Consists.

12.9.8 The Contractor shall submit configuration details, electrical insulation ratings, and strength analyses for the wire reel mounting for MBTA's review and approval. [CDRL 12.9.8]

12.10 SAFETY REQUIREMENTS

12.10.1 Fall Protection

12.10.1.1 Fall protection anchors meeting the requirements of ANSI/SAIA A92.2-2015, Section 4.9.4, shall be provided on the lift platform/bucket for all personnel.

12.10.1.2 The Contractor shall provide specifications for fall prevention or protection systems for use with the lifts and meeting the requirements of 29 CFR 1910. [CDRL 12.10.1.2]

12.10.1.3 Placards shall be included on the lift platform/bucket stating "Fall System Required" or similar text.

12.10.2 Electrical Insulation

12.10.2.1 The lift system shall be configured to safely allow for gloving work, as defined by ANSI/SAIA A92.2-2015, on the live Green and Blue Line OCS.

12.10.2.2 Electrical insulation of the lift platform, lifting mechanism, wire handling devices, vehicle deck, and vehicle roof shall provide a system of double insulation, such that failure or bypassing of any single layer of insulation will not result in unsafe conditions for personnel in the lift, on the deck, or in the Operator Stations and Crew Cabin. Reference Section 2.4 for minimum and maximum line voltages.

12.10.2.3 The lift mechanism electrical insulation shall be Category C, rated for a line voltage of 5kV, in accordance with ANSI/SAIA A92.2-2015.

12.10.2.4 Lift system electrical insulation is considered secondary insulation. Gloves or tools with rated electrical insulation values are required for working on the live OCS. The Contractor is not required to provide gloves or tools.

12.10.2.5 High resistance upper control components may be proposed for MBTA's review and approval, provided that they meet the requirements of ANSI/SAIA A92.2-2015, Section 5.2.6.

12.10.2.6 The Contractor shall submit an electrical insulation plan demonstrating compliance with the requirements of this section and including deck and roof electrical insulation. [CDRL 12.10.2.6]

12.10.2.7 The Contractor shall submit electrical insulation qualification test reports for all components requiring rated electrical insulation. [CDRL 12.10.2.7]

12.10.2.8 The operations manual shall define all frequent and periodic electrical insulation tests required for compliance with ANSI/SAIA A92.2-2015 and OSHA requirements.

12.10.3 Backup System

12.10.3.1 The wire maintenances lifts and wire handling devices shall include a backup system that is capable of returning the lifts and handling devices to their stowed positions in the event of a primary power loss or failure of the hydraulic system.

13 SOFTWARE SYSTEMS

This section provides general requirements for Software Management, Hardware, Configuration, and Quality Assurance.

13.1 GENERAL

13.1.1 The Contractor shall propose a software system to meet the functions and requirements of this Specification.

13.1.2 The software system utilized shall be service proven or approved by the MBTA.

13.1.3 The Contractor shall supply licenses to the MBTA for all software used on all OCS Inspection Car Consist systems and PTEs for the life of the OCS Inspection Car Consists.

13.1.4 The Contractor shall utilize a Software quality assurance plan guided by IEEE 730 or equivalent.

13.1.5 The Contractor is responsible for the overall design, the partitioning of the requirements to the subsystems, and the integration of the subsystems into the complete system.

13.1.6 The Contractor shall submit Software System Functional Descriptions as part of the Preliminary Design Review Package for each vehicle system.

13.1.6.1 Software System Functional Descriptions shall include:

13.1.6.1.1 General description of the operation of the system software.

13.1.6.1.2 A complete list of all anticipated Software Configurable Items.

13.1.6.1.3 A complete list of all COTS software to be incorporated into the system software.

13.1.6.1.4 For all non-commercially available software used for vehicle systems, documentation meeting IEEE Standard 1558, Type 5 requirements or an MBTA-approved alternative shall be submitted.

13.2 SOFTWARE FUNCTIONS AND FEATURES

13.2.1 Software shall perform the following basic functions:

13.2.1.1 Implement the desired control scheme such that the specified performance is achieved.

13.2.1.2 Monitor all inputs for unsafe, erroneous, or unknown conditions or combinations of conditions and take appropriate actions to preserve proper functioning and capture appropriate information to facilitate root cause analysis and repair when necessary.

13.2.1.3 Sample all input conditions at rates sufficient to detect and remedy all unsafe or damaging conditions in the shortest possible time.

13.2.1.4 Limit all output commands to safe levels regardless of any combination of input conditions.

13.2.1.5 Perform self-diagnostic routines and respond promptly, safely, and predictably to detect faults. The self-diagnostics shall include tests for program corruption and integrity in read/write memories.

13.2.1.6 Respond safely and predictably when powering up or recovering from power interruptions.

13.2.1.7 Permit thorough interrogation of all input, output, and internal conditions by external diagnostic equipment.

13.2.1.8 Processor system parameters shall be adjustable via the PTEs.

13.2.1.8.1 Appropriate parameters shall be suggested by Suppliers for MBTA's review and approval.

13.2.1.8.2 User defined/changeable parameters shall be structured as tabulated data.

13.2.1.9 All software supplied by the Contractor and all subcontractors shall correctly handle times and dates throughout the possible life expectancy of the OCS Inspection Car Consists.

14 TESTING PROGRAM

This Section outlines the program to assure compliance with this Specification and with the Contractor's proposed design through the testing of components, systems, and the completed vehicle.

The tests outlined are general tests that the MBTA wishes to see; however, the Contractor shall develop a comprehensive test program to be approved by the MBTA that meets the intent of this Specification.

14.1 GENERAL

14.1.1 The Contractor shall develop and perform a comprehensive testing program to thoroughly test the OCS Inspection Car Consists before delivery, after delivery, and prior to issuance of conditional acceptance by the MBTA.

14.1.2 The Contractor may request the MBTA consider the application of previous tests which are supported by a documented service history record in lieu of testing for this contract.

14.1.3 The MBTA may, at its option, witness all tests. At least 15 days prior to each test performed, the Contractor shall notify the MBTA in writing of the date, time, and location the test will be performed.

14.1.4 Any defects in the equipment, material, or workmanship, discovered during any inspection or test, including defects in performance, safety, reliability and maintainability shall be corrected at no additional expense to the MBTA.

14.1.5 The Contractor shall be responsible for furnishing all the necessary testing instruments and apparatus to conduct the required tests.

14.1.5.1 All costs associated with the use of test instrumentation, apparatus, materials, labor, and facilities shall be borne by the Contractor.

14.1.6 The Contractor shall submit an Inspection and Test Plan for MBTA's review and approval as part of the Preliminary Design Review Package. [CDRL 14.1.6]

14.1.6.1 The Inspection and Test Plan shall be updated as required and resubmitted to the MBTA.

14.1.6.2 The Inspection and Test Plan shall include a comprehensive list of all written inspection and test procedures to be performed before, during, and after key manufacturing, assembly, and delivery tasks.

14.1.6.3 The Inspection and Test Plan shall include dates of activities to allow the MBTA to schedule personnel to attend.

14.1.6.4 The Inspection and Test Plan shall include any MBTA support or equipment needed to perform tests on the MBTA's property.

14.1.7 Records shall be kept of all inspection and testing results to provide objective evidence that specified product requirements have been met.

14.1.7.1 All records shall be included in the Car History Books. Refer to Section 16.7.

14.2 TEST REPORTS

14.2.1 For each test performed, a unique test report shall be prepared, regardless of the outcome of the test, and submitted to the MBTA. [CDRL 14.2.1]

14.2.1.1 All test failures shall be documented and included in test reports.

14.3 TEST SUMMARY

Description of Test	Qualification Test (First Car)	Pre-Shipment Test (All Cars)	Acceptance Test (All Cars)
Carbody Strength Tests	X		
Wheel Load and Carbody Balance Test	X		
Camber Test	X		
Carbody Water Tightness Test	X	X	
Engine Horsepower Test	X		
Engine Heat Test, preliminary	X		
Engine Heat Test, final			X
Engine Back Pressure Test	X		
Propulsion System Tests	X	X	X
Truck Performance Test	X	X	
Battery Test	X	X	
HVAC Test	X	X	
EMI Test	X		X
Reservoir Test		X	
Trip Cock Test		X	X
Pneumatic System Leakage Test		X	X
Braking System Tests	X	X	X
Parking Brake Test	X	X	X
Horn Test	X		
Coupler Swing Test		X	
Coupler Performance Test	X		X
Intercar Connection Test	X	X	X
Lighting Tests	X	X	X
Electrical Wiring Tests		X	
Defroster Test	X		
Communication Test	X	X	X

Description of Test	Qualification Test (First Car)	Pre-Shipment Test (All Cars)	Acceptance Test (All Cars)
Lift Strength and Stability Tests	X		
Lift Performance Tests		X	X
Wire Handling Device Strength Tests	X		
Roof and Deck Electrical Insulation Tests	X		X
Lift/Wire Handling Device/Wire Reel Electrical Insulation Tests	X		X
Noise, Shock, and Vibration Test	X		
Visual Inspection Test		X	X
Safety Feature Test		X	X
Functional Test of all Systems for Correct Operation		X	X
Curving Test	X		X
Clearance Test	X		X
Weight Test	X		X

14.3.1 Qualification Test

14.3.1.1 The Qualification Tests are typically one (1) time tests conducted to demonstrate compliance with the design requirements this Specification at operating and environmental extremes. These tests shall be performed on the first OCS Inspection Car Consist, system, subsystem, or component at the Contractor's or subcontractor's facility.

14.3.2 Pre-Shipment Test

14.3.2.1 The Pre-Shipment Tests shall be performed on all OCS Inspection Car Consists, systems, subsystems, or components at the Contractor's or subcontractor's facility to demonstrate compliance with the requirements of this Specification prior to shipping to the Contractor or the MBTA.

14.3.3 Acceptance Testing

14.3.3.1 The acceptance tests shall be conducted on all OCS Inspection Car Consists after delivery to the MBTA to verify OCS Inspection Car Consists performance and safety.

15 QUALITY AND SYSTEM ASSURANCE

This Section establishes criteria for the development and implementation of a quality and system assurance program to optimize the quality, reliability, maintainability, and safety aspects of the completed OCS Inspection Car Consists.

15.1 GENERAL

15.1.1 The OCS Inspection Car Consists shall be designed to provide a high degree of safety and reliability, and to minimize downtime during preventive and corrective maintenance activities.

15.1.2 Designs shall assure that OCS Inspection Car Consists perform as required without excessive failures, delays, interrupted service, or hazards to its crew members or the general public.

15.1.3 The requirements of this Section shall be applied to the Contractor and all subcontractors, including suppliers.

15.2 QUALITY ASSURANCE REQUIREMENTS

15.2.1 General

15.2.1.1 The Contractor shall establish and maintain a Quality Assurance (QA) Program that complies with ISO 9001 or approved equal and the FTA QA/QC Guidelines document FTA-IT-90-5001-02.

15.2.1.1.1 All subcontractors, whether foreign or domestic, shall also comply with this requirement.

15.2.1.2 The QA Program shall assure that all aspects of the Contract are in conformance with the design, materials and workmanship requirements provided in this Specification.

15.2.1.3 The approved QA Programs of the Contractor and all subcontractors shall not be changed without written approval by the MBTA.

15.2.1.4 The MBTA may verify implementation of any aspect of the Contractor's operation as it relates to Quality Control or Quality Assurance and shall have the right to conduct on-site fact-finding inspections and audits at the Contractor's and all subcontractors' facilities at any time.

15.2.1.5 The MBTA may conduct an initial audit of the Contractor's QA Program prior to issuance of the Purchase Order for this Contract.

15.2.1.6 MBTA may suspend the work if the Contractor fails to promptly correct deficiencies identified by the Contractor or the MBTA.

15.2.1.7 The content of the Contractor's Quality Assurance (QA) program shall be detailed in the Contractor's QA Manual, procedures, work instructions, and Project Quality Assurance Plan, and include such elements as identification of contract requirements, control of the design, materials, manufacturing, record keeping, inspections, tests, and audits.

15.2.2 Project Quality Assurance Plan (PQAP)

15.2.2.1 Within ninety (90) days after Notice-to-Proceed (NTP), the Contractor shall submit, for MBTA's review and approval, an overall Project Quality Assurance Plan (PQAP) for the Contractor and all subcontractors. [CDRL 15.2.2.1]

15.2.2.2 This plan shall identify the controls, resources, and skills the Contractor will apply for the duration of the Contract to satisfy project quality system requirements.

15.2.2.2.1 The PQAP shall address each of the clauses in ISO 9001 and FTA-IT-90-5001-02.

15.2.2.2.2 For each specified quality system requirement, the PQAP shall identify how it will be satisfied, when, where, and by which job function.

15.2.2.2.3 Internal quality auditing shall be defined in the PQAP.

15.2.2.2.4 The PQAP shall include a flow chart of the manufacturing sequence with all planned inspections, tests, hold points, and customer witness points indicated.

15.2.2.2.4.1.1 The flow chart shall indicate entities participating in the inspections.

15.2.2.2.5 Required inspection equipment, measurements, personnel certifications and training, workmanship acceptance standards, methods of inspection, quality record documentation, and a nonconforming material report template (NCR) shall be identified in the PQAP.

15.2.2.2.6 The PQAP shall include requirements for document and data control, including control of quality records.

15.2.2.2.7 The PQAP may refer to specific sections of other Contractor documents, such as the Quality Manual and supporting procedures, if such documents are applicable to this project.

15.2.3 Control and Calibration of Measurement Tools and Test Equipment

15.2.3.1 Measurement tools and test equipment shall be kept in current calibration over the length of the Contract.

15.2.3.2 The Contractor and any subcontractors shall establish and utilize control and calibration procedures to ensure that only calibrated measurement tools and test equipment are used.

15.2.3.3 The method and period of recalibration shall be in accordance with a recognized national standard.

15.2.3.4 The Contractor and any subcontractors shall keep on file a certification of calibration for all measurement tools and test equipment.

15.2.3.5 Calibration status, including calibration due date, shall be marked on all measurement tools and test equipment.

15.2.3.6 Inspection and test records shall include the identification and calibration status of all measurement tools and test equipment used.

15.2.3.7 Measurement tools and test equipment shall be suitably stored to ensure continued accuracy and fitness for use.

15.2.3.8 Control and calibration procedures shall contain provisions for determining the validity of previous measurements and tests and taking appropriate corrective action if measurement tools or test equipment are found out of calibration.

15.2.4 Failure Analysis

15.2.4.1 The Contractor shall perform a documented failure analysis to determine the root cause of all failures, the corrective action required to resolve the failures, and the preventive action required to prevent future related failures.

15.2.4.2 The Contractor shall establish and maintain procedures for performing failure analyses, as well as taking corrective and preventive actions that are appropriate for the size of the problems and commensurate with the risks that they present. [Included in CDRL 15.2.2.1]

15.2.4.2.1 Corrective action procedures shall include methods such as root cause investigation, problem analysis, recording results, determining the most effective corrective action, verifying that corrective actions have been taken, and that they are effective.

15.2.4.2.2 Preventive action procedures shall include methods such as data and information analysis, determining the best approaches to preventing nonconformity, implementing and ensuring effectiveness of preventive action plans, and forwarding significant details of actions taken for review by the MBTA.

15.2.5 Nonconforming Material Report (NCR)

15.2.5.1 Whenever nonconformances are identified by the Contractor or the MBTA, the Contractor shall prepare a nonconforming material report (NCR).

15.2.5.2 The NCR shall reference the inspection record in which the nonconformance was identified and the documented failure analysis.

15.2.5.3 The NCR shall list the corrective and preventive actions taken as a result of the nonconformance.

15.2.5.3.1 Multiple corrective and preventive actions for the same nonconformance may be grouped onto a single NCR in order to reduce the quantity of paperwork generated.

15.2.5.4 Templates for NCRs shall be submitted for MBTA's review and approval as part of the PQAP. [Included in CDRL 15.2.2.1]

15.2.5.5 NCRs shall be included in the Car History Books. Refer to Section 16.7.

15.2.6 Documentation

15.2.6.1 All reports, plans, programs, procedures, schedules, and other materials prepared for the Contract work to be performed by the Contractor or any subcontractors shall be the property of the MBTA.

15.2.6.1.1 The Contractor shall provide copies and access to these materials during the progress of the Contract upon request.

15.2.6.1.2 All such reports, plans, programs, procedures, schedules, and other materials shall be readily accessible to the MBTA.

15.2.7 MBTA Product and Process Audit

15.2.7.1 The MBTA reserves the right to audit any product or process at any time throughout the build of the OCS Inspection Car Consists.

15.2.7.2 The Contractor shall extend to the MBTA its full cooperation and, at no additional cost to the MBTA, provide facilities at its car construction plants, including final assembly sites.

15.2.7.2.1 These facilities shall enable convenient examination of materials, work, and equipment.

15.2.7.2.2 There shall be provisions for separated, securable office space, desks, internet access, lockers, and file cabinets.

15.2.7.3 Current copies of all drawings, diagrams, schedules, changes, deviations, and data shall also be furnished to the MBTA's in-plant representatives.

15.2.7.3.1 Data shall be maintained to current standards, so it is useful to verify design, construction, assembly, installation, workmanship, clearance, tolerance, and functionality of the cars.

15.2.8 First Article Inspection (FAI)

15.2.8.1 A First Article Inspection (FAI) shall be performed jointly by the MBTA and the Contractor on all major systems and subsystems. FAIs may include, but not limited to, the following:

15.2.8.1.1 Carbody structure (including paint and finish), coupler assembly, propulsion ECU, transmission, diesel engine, main battery, truck frame structure, truck assembly (including suspension and friction brake assembly), OCS Inspection System, wire handling devices, wire maintenance lifts, hydraulic supply system, and fully assembled and operational OCS Inspection Car Consists.

15.2.8.2 The FAI shall include inspections and tests sufficient to demonstrate complete system, subsystem, and component functionality, as well as compliance with all requirements of this Specification, to the extent that is practical.

15.2.8.3 All production work performed prior to approval of the FAI shall be at the sole risk of the Contractor.

15.2.8.3.1 The Contractor shall be financially responsible for any rework or repeat inspections due to nonconforming items identified during FAI.

15.2.9 FAI Schedule

15.2.9.1 The Contractor shall maintain a log of all FAIs, including the FAI description, FAI status, FAI schedule, FAI package status, corresponding letter numbers (both submittals and responses), and FAI report status. [CDRL15.2.9.1]

15.2.9.1.1 The Contractor shall keep the log current and submit it to the MBTA at least once per month, from 120 days after NTP until all FAIs are completed.

15.2.9.1.2 The Contractor shall not schedule more than two FAIs on the same date or two FAIs in different locations within the same work week without prior approval by the MBTA.

15.2.9.2 The Contractor shall provide an individual notice to the MBTA for each FAI at least 30 calendar days prior to the FAI.

15.2.9.2.1 The Contractor shall not conduct the FAI until the MBTA has approved the FAI package. FAIs may not be conducted until the design drawings of the article have been approved and all open issues from design reviews are resolved.

15.2.10 FAI Package

15.2.10.1 The Contractor shall submit a FAI package to the MBTA in advance of the FAI. [CDRL 15.2.10.1]

15.2.10.2 Each package shall be identified as a CDRL with a unique number suffix, as identified in the FAI Plan.

15.2.10.3 The FAI package shall include the following items at a minimum.

15.2.10.3.1 Schedule and agenda of inspection.

15.2.10.3.2 Contractor name, address, phone number, and contact.

15.2.10.3.3 Component list with status of all design documentation.

15.2.10.3.4 Copy of the latest revision of all design documentation.

15.2.10.3.5 Contractor inspection plan and procedures.

15.2.10.3.6 Participating Contractor representatives.

15.2.10.3.7 Material and component certifications.

15.2.10.3.8 In-process and final inspection reports.

15.2.10.3.9 Qualification and Pre-Shipment Test Reports.

15.2.10.3.10 Work space in which FAI will be performed.

15.2.10.3.11 Tooling, test, and measurement equipment that will be used for the FAI, along with utilities required to use said equipment.

15.3 SYSTEM ASSURANCE REQUIREMENTS

15.3.1 Reliability

15.3.1.1 All assemblies, subassemblies, and components shall be designed for operating in a rail transit environment under the conditions outlined in Section 2 or have a proven service history.

15.3.1.2 To demonstrate reliability in the MBTA's operating environment, a thirty day Performance Reliability Period of operation at the normal duty cycle shall be conducted prior to acceptance of each OCS Inspection Car Consist. During the Performance Reliability Period, the MBTA's personnel, with the assistance of a qualified Contractor representative, will perform routine maintenance as required by the approved manuals.

15.3.1.3 The Contractor shall submit a failure analysis report for all failures that occur during the Performance Reliability Period.

15.3.1.3.1 Failure analysis reports shall identify the cause of the failure and propose corrective and preventive action to addresses the failure, subject to MBTA's review and approval.

15.3.1.4 Once approved, all corrective and preventive actions proposed in the failure analysis report shall be implemented by the Contractor at no additional cost to the MBTA.

15.3.1.5 The Performance Reliability Period shall begin following successful completion of all conformance and acceptance tests required by Section 14.

15.3.1.6 The Performance Reliability Period shall be restarted in the event of one design failure or two quality failures.

15.3.1.6.1 Design Failures are those which require a re-design in a component, system or subsystem to resolve a failure.

15.3.1.6.2 Quality failures are those in which a component, system or subsystem is replaced in-kind.

15.3.2 Maintainability

15.3.2.1 **Maintainability Design**

15.3.2.1.1 All equipment shall incorporate design for maintainability as a design goal.

15.3.2.1.2 Built in test points and test connectors shall be provided and marked for all major subsystems.

15.3.2.1.2.1 Test points shall interface with commercially available test equipment or with the portable test equipment provided by the Contractor.

15.3.2.1.2.2 Test connectors shall be commercially available; custom adaptors are not permitted.

15.3.2.1.3 All test points, fault indicators, modules, wire junctions, pipes, tubes, connectors and wires shall be identified by name plates, color coding, number coding, or other means as approved by the MBTA.

15.3.2.1.4 All systems and components serviced as part of inspection or periodic maintenance shall be readily accessible without removal of unrelated components.

15.3.2.1.5 The minimum number of fasteners required for sufficient strength and performance shall be used to secure access covers.

15.3.2.1.6 Access panels and openings shall be sufficient in quantity, size, and placement to permit ready access from normal work locations.

15.3.2.1.7 Doors or cover panels shall be hinged and be removable if they cannot swing fully open.

15.3.2.1.8 Standard and commercially available components and hardware shall be used wherever suitable.

15.3.2.1.9 Major components shall be designed for removal by provision of handles, lifting eyes, lugs, or pads.

15.3.2.1.10 The use of special tools and fixtures for maintenance shall be kept to a minimum. Special tools and fixtures are subject to MBTA's review and approval.

15.3.2.1.11 Assemblies or components that are functionally interchangeable shall be physically interchangeable.

15.3.2.1.12 Assemblies or components that are not functionally interchangeable shall not be physically interchangeable and be shaped or keyed to prevent incorrect application.

15.3.2.2 **Maintenance Program**

15.3.2.2.1 At least 120 days prior to delivery of the first OCS Inspection Car Consist, the Contractor shall submit a Maintenance Program for MBTA's review and approval. [CDRL 15.3.2.2]

15.3.2.2.2 The Maintenance Program shall detail all preventative maintenance activities recommended by the Contractor and all subcontractors for the MBTA to perform for the specified service life of the OCS Inspection Car Consists, reference Section 2.1.1.2.

15.3.2.2.3 Operating parameters and assumed duty cycle shall be clearly defined in the Maintenance Program.

15.3.2.2.4 Supporting documentation for the Maintenance Program shall follow the arrangement provided in APTA PR-IM-RP-002-98, latest revision or other MBTA-approved format.

15.3.2.2.5 For each maintenance task, the Maintenance Program shall outline the task description, maintenance intervals, time to complete maintenance, tools, components, or materials required, quantity of personnel, and skill levels required.

15.3.2.3 **Maintainability Demonstration**

15.3.2.3.1 As part of the training program for maintenance personnel, the Contractor shall demonstrate select maintenance and troubleshooting tasks. [CDRL 15.3.2.3.1]

15.3.2.3.2 The tasks included in the Maintainability Demonstration shall be determined by the MBTA, but include, at a minimum, the items listed below.

15.3.2.3.2.1 Use of special tools.

15.3.2.3.2.2 Removal and replacement of line replaceable units.

15.3.2.3.2.3 Vehicle movement under disabling conditions.

15.3.2.3.2.4 Diesel Engine maintenance.

15.3.2.3.2.5 Diesel Engine removal and replacement.

15.3.2.3.2.6 Transmission overhaul.

15.3.2.3.2.7 Air compressor removal and replacement.

15.3.2.3.2.8 Hydraulic pump removal and replacement.

15.3.2.3.2.9 Truck change-out.

15.3.2.3.2.10 Wheel truing.

15.3.2.3.2.11 Electrical Insulation testing

15.3.2.3.2.12 Lift maintenance

15.3.2.3.2.13 Wire handling device maintenance

15.3.2.3.2.14 Wire reel maintenance

15.3.2.3.2.15 OCS Inspection System maintenance

15.3.2.3.3 The Contractor shall demonstrate that the time to complete each maintenance task falls within the value provided in the Maintenance Program.

15.3.3 Consumable Parts List

15.3.3.1 At least 180 days prior to the delivery of the first OCS Inspection Car Consist, the Contractor shall submit a Consumable Parts List for MBTA's review and approval. [CDRL 15.3.3.1]

15.3.3.2 This list shall identify all parts required to maintain the OCS Inspection Car Consists, including the Contractor's name and address, Contractor's part number, part description, unit cost, anticipated lead time, and estimated annual usage.

15.3.4 Safety

15.3.4.1 System Safety Program

15.3.4.1.1 The Contractor shall design, build, test, and certify the OCS Inspection Car Consists to achieve acceptable safety for crew members and persons nearby under normal operating conditions and in the event of equipment failures.

15.3.4.1.2 The Contractor shall ensure that all safety aspects have been considered and resolved for each individual system, the integrated vehicle systems, and the interaction between the vehicle and the operating environment.

15.3.4.1.3 The Contractor shall implement a System Safety Program (SSP) including a robust Hazard Management process per MIL-STD-882E or equivalent.

15.3.4.1.4 At a minimum, the SSP shall cover hardware safety, software safety, fire safety, electromagnetic compatibility, security, and interaction between the vehicle and the operating environment.

15.3.4.1.5 Operating environment considerations shall include, but not be limited to, train control, track work, passenger stations, and maintenance facilities.

15.3.4.1.6 The Contractor shall provide a System Safety Program Plan (SSPP) within ninety days after NTP. [CDRL 15.3.4.1.6]

15.3.4.1.6.1 The SSPP shall specify the SSP scope, objectives, activities, schedule, deliverables, reporting, program participants (name and organization), and methods by which Contractor will meet the MBTA system safety requirements.

15.3.4.1.6.2 The SSPP shall define SSP interfaces with other program elements, such as project planning, management, scheduling, supplier control, reliability, maintainability, manuals, training, technical requirements, vehicle design, subsystem design, software development, quality assurance, analysis, and test.

15.3.4.2 Failure Induced Hazards

15.3.4.2.1 Vehicle equipment and systems shall be designed and constructed to revert to safe modes under failure conditions.

15.3.4.2.1.1 The Contractor shall employ high quality components, service proven systems, redundancy, checking devices, and other techniques to accomplish this goal.

15.3.4.2.2 Vehicle systems that could result in injury to a person or damage to the vehicle shall conform to the following design principles:

15.3.4.2.2.1 The failure of a single device shall not result in a permissive condition.

15.3.4.2.2.2 An undetected failure of any device shall not permit a subsequent device failure to result in a permissive condition.

15.3.4.2.3 Systems shall conform to the safety design principals by one or both of the following methods:

15.3.4.2.3.1 The utilization of vital devices.

15.3.4.2.3.2 Independent channels with independent checking of each channel.

15.3.4.2.3.2.1 All channels shall require a permissive state for the controlled system to achieve a permissive state.

15.3.4.2.3.2.2 Failure in any channel shall not affect any other channel.

15.3.4.2.3.2.3 Differences in state between channels shall be alarmed and result in a restrictive state on the system.

15.3.4.2.4 The term 'failure' includes both the initial device failure and all consequential device failures caused by the initial failure.

15.3.4.2.5 The term 'device' includes any component, subsystem, or system, whether electrical, mechanical, pneumatic, or hydraulic.

15.3.4.2.6 The terms 'restrictive' and 'permissive' relate to potential system responses which result in a more safe or less safe condition, respectively.

15.3.4.2.7 The term 'vital' includes devices with known, manufacturer-guaranteed failure modes.

15.3.4.2.8 Equipment failures which result in an indication of danger, whether or not actual danger exists, shall be considered to have occurred in a safe manner.

15.3.4.2.8.1 Conversely, a failure that results in an indication of safety when, in fact, a dangerous condition may exist, shall be considered unsafe.

15.3.4.3 **Hazard Analyses**

15.3.4.3.1 The Contractor shall perform robust hazard analyses to demonstrate that the vehicle conforms to the requirements of this Specification, as well as all applicable Federal, Massachusetts State, and Local safety regulations.

15.3.4.3.2 The Contractor shall use standard failure and safety analysis methods and experiential failure rates for components wherever possible.

15.3.4.3.3 The Contractor shall select analysis methods that are appropriate for the system under evaluation and the hazard severity, subject to MBTA's review and approval.

15.3.4.3.4 All identified hazards shall be either eliminated or reduced to levels of risk acceptable to the MBTA.

15.3.4.3.5 The Contractor shall adjust or amend all hazard analyses as the vehicle design and construction progresses.

15.3.4.3.6 The Contractor may offer existing hazard analyses of like equipment operating under like conditions in lieu of performing a complete analysis of the proposed equipment, subject to MBTA's review and approval.

15.3.4.3.7 **Preliminary Hazard List (PHL)**

15.3.4.3.7.1 The Contractor shall submit a Preliminary Hazard List (PHL), for MBTA's review and approval, no later than ninety days from NTP. [CDRL 15.3.4.3.7.1]

15.3.4.3.7.2 The Contractor shall identify all failure-induced and normal operating (non-failure condition) hazards falling into severity categories 1, 2, and 3 as defined in MIL-STD-882E.

15.3.4.3.7.3 All hazards shall be assigned a severity and the PHL be prioritized as to severity.

15.3.4.3.7.3.1 The PHL shall be a complete list of all identifiable events and their unmitigated severity level.

15.3.4.3.7.3.2 All identified hazards shall be given a unique identifier for tracking purposes.

15.3.4.3.7.4 In addition to those hazards identified by the Contractor, the following hazards shall be included in the listings and be considered hazards of Category 1 or 2 severity:

15.3.4.3.7.4.1 Emergency brake fails to apply when requested.

15.3.4.3.7.4.2 Service brakes fail to apply when requested.

15.3.4.3.7.4.3 Propulsion fails to cease when requested.

15.3.4.3.7.4.4 Indication of being uncoupled when not uncoupled and indication of being coupled when not coupled.

15.3.4.3.7.4.5 Excessive currents or overheated equipment cause fire.

15.3.4.3.7.4.6 Vehicle moves in wrong direction.

15.3.4.3.7.4.7 Use of material that is hazardous to personnel or the environment.

15.3.4.3.7.4.8 Electric shock.

15.3.4.3.7.4.9 Excessive EMI from vehicle system interferes with signal system or other vehicle systems.

15.3.4.3.7.4.10 Derailment or overturn due to vehicle dynamics.

15.3.4.3.7.4.11 Wire maintenance lifts or wire positioning devices change position when not requested.

15.3.4.3.7.4.12 Overturn due to wire maintenance lifts in unsafe position or overloaded.

15.3.4.3.7.4.13 Wire handling devices overloaded.

15.3.4.3.7.4.14 Fallen wire during OCS Maintenance

15.3.4.3.8 **Preliminary Hazard Analysis (PHA)**

15.3.4.3.8.1 The Contractor shall submit, for MBTA's review and approval, a Preliminary Hazard Analysis for all Severity 1, 2, and 3 hazards as part of the Preliminary Design Review Package. [CDRL 15.3.4.3.8.1]

15.3.4.3.8.2 The PHA shall be an initial assessment of hazards that identifies potential provisions to control each hazard, consistent with MIL-STD-882E.

15.3.4.3.8.3 The PHA shall include an analysis of the complete vehicle integrated with the subsystems, operations, maintenance, and environmental hazards.

15.3.4.3.8.4 The Contractor shall use a Fault Tree Analysis (FTA), Failure Modes, Effects, and Criticality Analysis (FMECA), or other MBTA-approved method to identify potential causes and effects of each hazard and determine potential corrective actions to eliminate or control the hazard.

15.3.4.3.8.5 The PHA shall include a general description of the hazard, estimation of the hazard severity, list of potential causes and effects, and potential corrective actions for each hazard.

15.3.4.3.8.5.1 Mitigation for undetected failures shall include an additional detectable failure.

15.3.4.3.9 **Hazard Log**

15.3.4.3.9.1 The Contractor shall maintain a Hazard Log throughout the course of the Contract.

15.3.4.3.9.2 The Hazard Log shall be regularly updated and submitted to the MBTA at least every ninety days from PDR until acceptance of the last vehicle.

15.3.4.3.9.2.1 A description of the major changes incorporated, and a checklist of the requirements identified in the PHA shall accompany each submittal.

15.3.4.3.9.3 The Hazard Log shall be used to document status of all mitigation requirements identified in the PHA.

15.3.4.3.9.4 The Hazard Log shall identify any additional hazards discovered during the design, fabrication, and test processes that were not included in the PHA.

15.3.4.3.9.4.1 Mitigations shall be provided for each additional hazard discovered.

15.3.4.3.10 **Safety Verification**

15.3.4.3.10.1 Prior to shipment of the first vehicle, a Safety Verification shall be submitted, for MBTA's review and approval, demonstrating that all requirements identified in the PHA and Hazard Log have been completed. [CDRL 15.3.4.3.10.1]

15.3.4.3.10.2 All applicable analysis, test, and inspection results shall be provided as appendices to the safety verification.

15.3.4.4 **Fire Safety**

15.3.4.4.1 The vehicle design shall include equipment and materials that provide sufficient fire resistance to prevent fires or, if a fire cannot be prevented, to reasonably ensure adequate time to detect the hazard and safely evacuate crew members.

15.3.4.4.1.1 Areas of the vehicle body that separate major ignition sources, energy sources, or sources of fuel-load from the interior of the operator and crew cabin shall have sufficient fire endurance to meet this requirement.

15.3.4.4.2 Materials used in the vehicles shall meet the test performance criteria for flammability and smoke emission characteristics specified in Appendix B of 49 CFR 238.

15.3.4.4.3 The Contractor shall submit certification from its suppliers that a representative sample of all combustible materials have been tested by a recognized independent testing laboratory and that the results comply with 49 CFR 238, Appendix B. [CDRL 15.3.4.4.3]

15.3.4.4.3.1 In lieu of the above requirement, the Contractor may demonstrate mitigation of flame, smoke, and smoke toxicity hazards through the hazard analyses required in Section 15.3.4.3, subject to MBTA's review and approval.

15.3.4.4.4 The Contractor shall perform a Fire Safety Analysis in accordance with 49 CFR 238.103(c).

15.3.4.4.5 The Fire Safety Analysis shall be submitted for MBTA's review and approval as part of the Preliminary Design Review. [CDRL 15.3.4.4.5]

15.3.4.4.5.1 The Fire Safety Analysis shall be updated by the Contractor and resubmitted to the MBTA to account for any changes to materials or design that affect the fire safety of the vehicle. In lieu of this requirement, the Contractor may demonstrate mitigation of fire hazards through the hazard analyses required in Section 15.3.4.3, subject to MBTA approval.

15.3.4.4.6 The Contractor shall provide written procedures for inspection, testing, and maintenance of all fire safety systems and equipment. [CDRL 15.3.4.4.6]

15.3.5 **Markings and Signage**

15.3.5.1 The Contractor shall clearly and permanently label or tag each air-line, hose, and valve; all electrical wiring, breakers, and receptacles; each electrical box, locker, and panel; each equipment box, locker, and compartment; and each item inside each box, locker, panel, and compartment.

15.3.5.2 Safety signs (warning/danger/caution) shall be provided in compliance with OSHA standards and ISO 3864.

15.3.5.3 Labels, tags, and signs shall be applied proximate to the item or as part of the item assembly.

15.3.5.4 Labels, tags, and signs shall be made from embossed or intaglio stainless steel or etched aluminum and affixed with mechanical fasteners. Plastic, self-adhering tags may not be utilized.

15.3.5.5 Labels, tags, and signs, as well as their fasteners, that are exposed to electrical equipment shall be covered with insulating paint.

15.3.5.6 Edge-sealed decals for the various system functions and instructions shall be applied where applicable.

16 CONTRACT MANAGEMENT

This Section specifies the requirements for Contract Management including a program management plan, schedules, milestones, deliverables, design reviews, and correspondence control. The requirements within this section will enable the MBTA to ascertain that the Contractor will meet the requirements of this Specification and monitor the contractual effort.

16.1 MANAGEMENT PLAN

16.1.1 The Contractor shall establish an organization to properly manage this Contract and be highly responsive to the needs of the MBTA as required in the Contract.

16.1.2 The Contractor shall provide a comprehensive Program Management Plan (PMP) within 90 days of NTP. [CDRL 16.1.2]

16.1.3 The PMP shall describe all work required by this Specification and include, but not necessarily be limited to:

16.1.3.1 An Organization Chart identifying all key personnel including for Contractor, subcontractors, and major equipment suppliers.

16.1.3.1.1 The Organizational Chart shall define and describe roles and responsibilities, reporting structure, all key positions, personnel and their respective duties and responsibilities.

16.1.3.1.2 Organizational charts shall be revised, as required, for all phases of the work.

16.1.3.2 The internal methods and communications to be used to control the program schedule, technical performance, program changes, MRB repairs, subcontracts, purchase orders, material procurement, and field service support.

16.1.3.3 A Master Program Schedule showing key milestones and events. Refer to Section 16.3.

16.1.3.4 A schedule identifying all elements of design and manufacture requiring approval or otherwise deliverable under the terms of the Contract indicating when and for which items the MBTA approval is required, to the level of the individual item submittal.

16.1.3.5 A flowchart of all project tasks indicating task integration including subsystems integration, industrial design, weight control, and conceptual design of the vehicles.

16.1.3.6 A detailed description of all processes and procedures that will be utilized by the Contractor to fulfill all of the requirements of this Contract.

16.2 CORRESPONDENCE MANAGEMENT

16.2.1 Correspondence management is a collection of activities related to the control, exchange, and coordination of information among the entire team, including the Contractor, the MBTA, and the MBTA project management team. The Contractor shall coordinate and facilitate

project correspondence, a critical link among people, ideas, and information for program success.

16.2.2 Deliverables shall include, but are not limited to:

16.2.2.1 Correspondence Management Plan;

16.2.2.2 Project Progress and Status Reports;

16.2.2.3 Progress Review Meetings.

16.2.3 Correspondence Plan

16.2.3.1 The Contractor shall develop, maintain, participate in, and administer a correspondence management plan, which identifies stakeholder information needs, distribution methods, and status reporting requirements (such as status meetings, progress reports, project reports, project presentations, etc.). [CDRL 16.2.3.1]

16.2.3.2 The plan shall ensure general awareness of the program requirements among the Contractor, its subcontractors and the MBTA and include provision to report program milestones against those expectations.

16.2.4 Progress Review Meetings

16.2.4.1 Progress meetings shall be scheduled and attended by the Contractor, and as required, by its subcontractors on a monthly basis to review progress of the project.

16.2.4.2 Progress meetings shall be used to summarize and review the progress reports, written correspondence exchanged since the last meeting, and open action items.

16.2.4.3 Progress Meeting Agendas shall address the topics to be addressed during the meeting and be distributed by the Contractor a minimum of five working days in advance of any regularly scheduled Progress Meeting.

16.2.4.4 The Contractor's authorized technical representative(s) shall also attend progress review meetings and technical meetings as required to discuss technical aspects of the project and to review comments on documents.

16.2.4.4.1 The Contractor's technical representatives shall be familiar with detailed design issues to facilitate quick resolution through discussion with the MBTA's technical representatives.

16.2.4.4.2 When appropriate, these technical meetings shall be conducted as extensions to the progress meetings.

16.2.4.5 Progress review meeting shall include evaluation of the Contractor's performance of the Contract requirements and any workaround plans that are applicable.

16.2.5 Monthly Progress Report

16.2.5.1 The Contractor shall develop and submit a Monthly Progress Report template, for MBTA's review and approval, no later than 30 days after NTP. [CDRL 16.2.5.1]

16.2.5.1.1 Using the MBTA approved report format, the Contractor shall prepare and submit this report to the MBTA for review on a monthly basis. [CDRL 16.2.5.1.1]

16.2.5.2 The report shall describe the budget status, project progress during the report period, projected activities for next report period, and actions required by the MBTA (if applicable).

16.2.5.3 The report shall analyze causes for reported delays and explain reasons for any variances with the Master Program Schedule (MPS) and provide plan and schedule for implementing appropriate corrective and preventive actions.

16.2.5.4 The Monthly Progress Report shall be provided within 7 calendar days of the close of the previous month and be the focal point for the Contractor progress review meeting for each month's Reporting Period. [CDRL 16.2.5.4]

16.2.6 Correspondence Control

16.2.6.1 All correspondence and submittals shall be via numbered and coded letter.

16.2.6.2 All correspondence and submittals shall be exchanged and posted via an MBTA project website or other means specified by the MBTA.

16.2.6.3 Submittals or information exchanged via means other than official project correspondence shall have no force.

16.3 MASTER PROGRAM SCHEDULE (MPS)

16.3.1 Within 30 days after NTP, the Contractor shall develop and submit an MPS to the MBTA. [CDRL 16.3.1]

16.3.1.1 The MPS shall provide a graphical representation of the project and identify all milestones, activities, durations, dependencies, earliest and latest possible dates for accomplishing each milestone and activity, the shortest and longest permissible time span between each, and major and minor paths that are critical for accomplishment of program objectives.

16.3.2 The MPS shall be monitored and controlled by the Contractor's management team responsible for all management functions and be updated and submitted, for MBTA's review and approval, at least monthly during the design, production, and acceptance phases of the Contract. [CDRL 16.3.2]

16.3.2.1 To allow for project evaluation, the monthly updated schedule shall display the project status and provide a comparison to the original schedule.

16.4 DESIGN REVIEW PROGRAM

16.4.1 The Contractor shall schedule and conduct design reviews with the MBTA for all vehicle components, systems, and for electrical and mechanical integration.

16.4.2 The Contractor shall successfully complete the design review program before requesting the MBTA to participate in First Article Inspections.

16.4.2.1 Dates for each Design Review and FAI shall be provided in the Master Project Schedule (MPS).

16.4.3 The Contractor shall structure the design review program to include the following:

16.4.3.1 Preliminary Design Review (PDR) is a phase to review the system design, conceptual drawings, hardware, software, and contract deliverables not addressed elsewhere.

16.4.3.2 Intermediate Design Review (IDR) is a phase to allow the Contractor and the MBTA to address all outstanding PDR items, obtain all necessary specific approvals, and work together to ensure clear direction and expectations are established to support entering Final Design Review.

16.4.3.3 Final Design Review (FDR) is a phase to allow the Contractor and the MBTA to review, revise, and agree on the details of the final design prior to release for manufacture.

16.4.4 The Contractor shall provide Design Review document packages to the MBTA at least 30 days prior to each design review for each phase.

16.4.4.1 Preliminary Design Review (PDR) Packages [CDRL 16.4.4.1]

16.4.4.2 Intermediate Design Review (IDR) Packages [CDRL 16.4.4.2]

16.4.4.3 Final Design Review (FDR) Packages [CDRL 16.4.4.3]

16.4.5 Design reviews shall address hardware, software, system functions and integration of interfaces with other systems, performance requirements, special tools and test equipment, technical documentation; and reliability, availability, maintainability, and safety.

16.4.6 During processes of design development, manufacturing, and testing, the Contractor shall validate the design, confirming that it meets defined MBTA requirements.

16.4.7 MBTA's Review and Approval

16.4.7.1 The MBTA's primary purposes for its review of design information, drawings, documents and data are to determine: compliance with the requirements of this Specification, standards, codes and regulations; suitability of the design for its intended purpose in regard to functions and features that may not be explicitly specified as requirements in this Specification, but are necessary to meeting the MBTA's needs; suitability of the submitted material to support the MBTA's needs to understand, operate, and maintain

the vehicle and all its systems; and suitability of the submitted material to support the MBTA's duties and responsibilities pertaining to the execution of this Contract.

16.4.7.2 The Contractor is responsible to ensure that all drawings, documents and data are of sufficient quality, clarity, and detail to support its required duties pertaining to the execution of this Contract. The MBTA, in the course of its review may, but is not obligated to, comment on deficiencies that may impede the Contractor's ability to perform Contractor duties.

16.4.7.3 The MBTA will review each submittal, as furnished by the Contractor within 30 days of its receipt. Upon completion of the review the MBTA will notify the Contractor in writing of the status of the submittal with one of the following dispositions:

16.4.7.3.1 **Proceed**: Review of the document did not identify noncompliant issues. The Contractor may proceed with the work addressed in the submittal.

16.4.7.3.2 **Proceed Pending**: The Contractor shall not proceed with the Work affected by the noted comments until the Contractor has responded to the comments; the comments have been reviewed; and the status of the submittal has been changed from "Proceed Pending" to "Proceed."

16.4.7.3.3 **Disapproved**: The Contractor shall not proceed with the Work. The Contractor shall revise and resubmit the submittal. The revised submittal shall address, to the satisfaction of the MBTA, all the comments provided in the disposition.

16.4.7.3.4 **Information**: This disposition is provided for submittals presented to explain an "approved equal" submittal, a concept and/or an approach to the Work, and appropriate conditions. The Contractor shall not proceed with the Work addressed in such submittals until the concept has been finalized and "approved."

16.4.7.4 The Contractor shall respond in writing to comments provided by the MBTA within 15 days of their receipt by the Contractor.

16.4.7.5 The Contractor shall not release any designs for manufacture before approval of the final design by the MBTA.

16.4.8 Design Review Meetings

16.4.8.1 30 days prior to each design review meeting, the Contractor shall submit a design review package containing design drawings, system functional description and supplemental information appropriate for the type of meeting.

16.4.8.1.1 The MBTA will review the design review package and provide comments and questions. The MBTA's comments and questions will form the basis for the design review meeting agenda. Additional review comments may be provided by the MBTA at the design review meeting and with transmittal of the design review meeting minutes.

16.4.8.2 Design Review meetings shall be held at locations as mutually agreed upon and may include sites of the Contractor and any of its subcontractors or suppliers.

16.4.8.3 Design review meeting minutes will be prepared by the MBTA.

16.4.8.4 The first design review meeting in each phase shall cover the overall system design.

16.4.8.5 Attendance at design review meetings shall include representatives of the Contractor, appropriate subcontractors and suppliers, and the MBTA and/or its representatives.

16.4.9 Specification Review

16.4.9.1 No later than 21 days after NTP, the Contractor's Program Manager, the Contractor's technical specialists, and major subcontractors and suppliers, shall meet with the MBTA to conduct a detailed review of this Specification.

16.4.9.1.1 During this meeting, the Contractor will be asked to provide an explanation of the approach planned in response to each requirement of this Specification. The MBTA will answer any questions the Contractor may have regarding requirements of this Specification.

16.4.10 Preliminary Design Review

16.4.10.1 The content of the Preliminary Design Review (PDR) package for each vehicle system or subsystem shall include:

16.4.10.1.1 Conceptual Design Drawings and System Functional Description

16.4.10.1.1.1 In lieu of or in addition to a complete set of electronic drawings, and with approval from the MBTA, the Contractor may propose a working session prior to or during PDR to provide an interactive overview of the conceptual design via 3D CAD or other means.

16.4.10.1.2 Technical and service information regarding the service proven design on which the proposed equipment is based.

16.4.10.1.3 Major components to be utilized, including alternative designs

16.4.10.1.4 Projected axle and vehicle weights of the consist and any correction plans

16.4.10.1.5 A tabulation of all interfaces with the vehicle and other systems.

16.4.10.1.6 A test plan identifying:

16.4.10.1.6.1 All qualification testing as required by this Specification or qualification by similarity as allowed by this Specification.

16.4.10.1.6.2 All routine testing as required by this Specification.

16.4.10.1.7 Software requirements.

16.4.10.1.8 Contract Deliverables specified in this Specification.

16.4.11 Intermediate Design Review

16.4.11.1 The content of the Intermediate Design Review (IDR) package for each vehicle system or subsystem shall include:

16.4.11.1.1 A System Functional Description of sufficient detail to completely describe the operation of the system.

16.4.11.1.2 A Software Requirements Specification.

16.4.11.1.3 Schematics and diagrams.

16.4.11.1.4 Process specifications, if appropriate.

16.4.11.1.5 Identification of all components to specific part number and associated required purchased component data.

16.4.11.1.6 Projected axle and vehicle weights of the consist and any correction plans.

16.4.11.1.7 Drafts of all qualification and routine test procedures identified in the Contractor's test plan.

16.4.11.1.8 A draft of all required manuals.

16.4.11.1.9 Contract Deliverables specified in this Specification.

16.4.12 Final Design Review

16.4.12.1 The Final Design Review (FDR) will take place when the design is essentially complete. All PDR and IDR issues shall be resolved prior to scheduling and commencing the FDR activity.

16.4.12.2 FDR shall include final projected axle and vehicle weights of the consist.

16.4.12.3 The FDR is to provide the opportunity to review, revise, and agree on the details of the final design prior to release of the designs for manufacture. Any open engineering items and related program management issues shall be discussed and resolved during the FDR to consider the FDR closed.

16.4.13 Working Sessions

16.4.13.1 The MBTA or the Contractor may request working sessions at any point in the design progression at mutually agreed times.

16.4.14 Changes

16.4.14.1 Requests for changes and "approved equal" shall be made in writing to the MBTA.

16.4.14.1.1 Each request shall include all pertinent information to verify that the item offered is equal to or exceeds the requirements of this Specification.

16.4.14.1.2 Any test requirements in this Specification that pertain to an item under consideration shall be included in the request submittal package.

16.4.14.1.3 Sample components may be submitted to the MBTA to facilitate the evaluation of the proposed alternative item. Such samples shall become the property of the MBTA.

16.4.14.1.4 The MBTA may request the Contractor to dismantle and/or functionally test such samples to establish the equality or superiority of form, fit, and function. The Contractor shall fulfill all such requests.

16.4.15 Contractor Submittals

16.4.15.1 All project correspondence and submittals shall be electronic. The electronic formats that will be accepted are:

16.4.15.1.1 Native MS Office (Word, Excel, PowerPoint, and Visio), Native AutoCAD .dwg, Drawing exchange, .dxf and other drawing formats, if a freely licensed viewer is available.

16.4.15.1.2 Generated and searchable Adobe PDF. A generated PDF file is a PDF file that has been created or saved to PDF format directly from the file's native application. A searchable PDF file is a file in which any and all text may be identified by the "Find" feature of Adobe PDF reader.

16.4.15.1.3 Solid models in a fully query-capable format such as Adobe PDF 3D. Other model viewer formats, if a freely licensed viewer is available. Where the Contractor's or subcontractor's documented procedures require that signed copies are produced, the hardcopy's signature page, and ONLY the signature page, may be scanned and inserted into an electronic file meeting the requirements above.

16.4.15.1.4 Scanned documents submitted without prior approval will not be reviewed.

16.4.15.2 All submitted drawings shall be in a consistent format and follow consistent conventions.

16.4.15.2.1 The Contractor shall define and seek approval of the project drawing format prior to the submittal of the first drawing for review by the MBTA.

16.4.15.2.2 All drawings shall identify the MBTA, Contract Number, and Vehicle Name on each drawing.

16.4.16 Design Submittals

16.4.16.1 The following is a partial list of the types of design information, drawings, documents and data that the Contractor and each supplier over the course of the project shall submit for approval. This list is intended to be illustrative. The Contractor is not constrained to submit only the types of information specified, nor are all types of information expected from all suppliers for all components and systems. All submittals will become property of the MBTA unless otherwise agreed to in writing by the MBTA.

16.4.16.1.1 Outline Drawings: Typically show basic envelope and interface dimensional information and may contain basic information regarding interface signals. They typically do not convey an understanding of the function or internal construction of a part or assembly.

16.4.16.1.2 Assembly Drawings: Similar to outline drawings with the addition of a bill of material or parts list and the identification of individual components.

16.4.16.1.3 Exploded View Assembly Drawings: Depict the assembly sequence of an assembly and are useful in assessing maintenance and maintainability requirements. They may also facilitate understanding the functions of mechanical equipment.

16.4.16.1.4 Fully Query-capable Solid Models: Communicates design intent directly and facilitates understanding the function and interrelationship of parts and components.

16.4.16.1.5 Diagrammatics: Functional representations of systems that may comprise electrical, electronic, pneumatic, hydraulic or other components. The requirements for Diagrammatics are the same as for schematics, except that more than one type of circuit may be shown.

16.4.16.1.6 Schematics: Functional representations of an electrical, electronic, pneumatic, hydraulic or similar circuit. Schematics are intended to facilitate the understanding, maintenance and repair of equipment, as such all elements of the circuit shall be fully detailed (“black boxes” are not allowed), all wire numbers, wire connections, terminal points, connectors and pin identifiers, ports and other interfaces shall be shown. Component ratings, values, set points and similar information shall be shown.

16.4.16.1.7 Interconnection Diagrams: Show the connections between components of a system. The connection may be individual wires, multiconductor cables, fiber optics, pipes or tubes, radio frequency, infrared, or others. Information shall be shown such as wire or pipe “to” and “from” points, wire type and gauge, wire numbers, terminal or connector identification, routing, pipe or tubing material and size and fittings.

16.4.16.1.8 Functional Descriptions or Design Reports Calculations and Analysis Reports: Describe the function of the equipment in concise and unambiguous terms. Mathematical expressions, logical statements, state diagrams, pseudo-code, flow charts and other similar descriptions shall be used in preference to textual descriptions.

16.4.16.1.9 Interface Control Documents: Define the external interfaces of a device, component or piece of equipment. All relevant information shall be provided, such as location of the interface, type of interface signal, scaling of the interface signal, limits and transmission protocols.

16.4.16.1.10 Software Documents: Refer to software documentation requirements.

16.4.16.1.11 Integrated vehicle schematics shall be prepared by the Contractor relating to all electrical, hydraulic, and pneumatic systems including component identification, component values, waveforms, voltages, currents, resistance values, wire identification, connector identification, and connector pin numbers. All components on PC boards shall be individually shown in the schematics. Schematics shall be comprehensive in nature and thoroughly detailed to permit the MBTA shop personnel to troubleshoot and repair vehicle systems.

16.4.16.2 The MBTA reserves the right to request additional documentation and drawings as required to clarify and amplify the intent of the documentation submitted.

16.5 SUBCONTRACTOR CERTIFICATION

16.5.1 The Contractor shall ensure that each subcontractor of major equipment has a complete copy of this Specification, inclusive of all appendices and that each subcontractor has access to referenced government and industry standards specified in this Specification.

16.5.2 The Contractor shall obtain from each of its subcontractors a written certification that the method being used for installation and connection of its equipment by the Contractor is satisfactory to the subcontractor and the certification be readily available to the MBTA. [CDRL 16.5.2]

16.6 AS-BUILT DRAWINGS

16.6.1 All technical information contained on the final approved working drawings of an as-built OCS Inspection Car Consist shall be submitted as as-built record drawings.

16.6.2 Within 30 Days after the delivery of the first OCS Inspection Car Consist, the Contractor shall furnish two sets of as-built record drawings and one set of electronic CAD files.

16.6.3 After approval of the as-built record drawings by the MBTA and no later than 30 Days after the Notice of Acceptance of the last OCS Inspection Car Consist, the Contractor shall furnish three sets of as-built record drawings.

16.6.4 The as-built record drawings shall show sufficient details and information for the MBTA to inspect, maintain, repair, and overhaul the OCS Inspection Car Consists, including ordering, manufacturing, and assembling all parts.

16.6.4.1 These drawings shall show parts as provided.

16.6.5 All assembly and system drawings shall be included in the Parts Catalog.

16.6.6 Any equipment modifications performed during the Warranty Period shall be reflected in a new set of as-built record drawing and CAD files.

16.6.7 After approval of as-built record drawings for the modifications, the Contractor shall submit three sets of as-built record and one set of electronic CAD files within 30 Working Days.

16.7 CAR HISTORY BOOKS

16.7.1 The Contractor shall submit a Car History Book (CHB) for each car at the time each car is conditionally accepted by the MBTA. [CDRL 16.7.1]

16.7.1.1 The CHB shall contain certified weight including scale tickets, a description of modifications and completion dates, a list of all defects noted during production and the actions taken for each, a list of serial-numbered apparatus, reports of each test and inspection performed, shipping documents, wheels, journal bearings and gear mounting records including pressing charts, all truck assembly and truck frame inspections and tests performed.

16.7.1.2 The Contractor shall be responsible for updating the configuration information and other relevant data during the Warranty Period.

16.8 REQUIREMENTS ALLOCATION AND MANAGEMENT

16.8.1 The Contractor and all subcontractors shall develop and employ a Requirements Allocation and Management Plan that traces each specific hardware or software functional requirement to this Specification and demonstrates compliance with all requirements of this Specification.

16.9 CONFIGURATION MANAGEMENT

16.9.1 General

16.9.1.1 The Contractor shall maintain accurate and current configuration control records.

16.9.1.2 The configuration and control records shall be available to the MBTA throughout the period of performance of the Contract and for a three-year period after final Contract payment.

16.9.1.3 The Contractor shall ensure that its subcontractor, supplier, or manufacturers' equipment, as incorporated into the vehicle design, conforms to the latest approved revision of the design documentation.

16.9.1.4 The Contractor shall prepare and submit a Configuration Management Plan within 90 days after NTP for MBTA's review and approval. [CDRL 16.9.1.4]

16.9.1.4.1 This plan shall detail how the Contractor intends to meet the configuration management requirements specified in this Section.

16.9.1.5 The Contractor shall prepare technical documentation to acceptable commercial standards and be capable of defining the approved configuration of system equipment in development, test, production, or operational use.

16.9.1.6 The technical documentation shall identify the configuration to the lowest level required to ensure repeatable performance, quality, and reliability.

16.9.1.7 The Contractor shall employ and maintain release records for technical documentation.

16.9.1.7.1 The records shall portray the relationship between identification elements.

16.9.1.7.2 Such relationships shall be limited to configuration requirements defined by engineering data.

16.9.1.7.3 It shall not reflect hardware or other product condition that varies from engineering requirements contained in these data, and not reflect manufacturing status.

16.9.2 Software Configuration

16.9.2.1 Software configuration management shall be described and submitted in a separate Software Configuration Management Plan (SCMP). [CDRL 16.9.2.1]

16.9.2.2 The SCMP shall include policies and procedures for ensuring software revision control for the software work products throughout the Contract life cycle.

16.9.2.3 The SCMP shall comply with IEEE STD 828 and IEEE STD 1558.

16.10 SERIAL AND CAR NUMBERS

16.10.1 The Contractor shall furnish the MBTA with a record of the serial numbers for major components as approved by the MBTA on all cars as delivered.

16.10.2 Car History Books shall include the serial numbers.

16.10.3 The serial number list shall be formatted by car number.

16.10.4 Car numbering scheme will be furnished by the MBTA.

17 IN-SERVICE SUPPORT

This section specifies the user education program to train the MBTA personnel on the use and maintenance of the OCS Inspection Car Consists along with requirements for manuals, parts catalogs, drawings, and support after the vehicles are delivered.

17.1 USER EDUCATION PROGRAM

17.1.1 General

17.1.1.1 The Contractor shall perform a User Education Program for the MBTA personnel responsible for operating and maintaining the OCS Inspection Car Consists.

17.1.1.2 The User Education Program shall have quality and depth sufficient to permit the MBTA personnel to safely and satisfactorily operate and maintain the OCS Inspection Car Consists, and to train other staff in the operation and maintenance of the OCS Inspection Car Consists.

17.1.1.3 The User Education Program shall cover the following topics at a minimum:

17.1.1.3.1 Instruction and reference material for the safe operation, maintenance, overhauling, and troubleshooting of the OCS Inspection Car Consists.

17.1.1.3.2 Recommended equipment inspection and test procedures.

17.1.1.3.3 Instructions for safe equipment access, removal, dismantling, and hoisting.

17.1.1.3.4 Instructions for using test equipment to monitor and troubleshoot all OCS Inspection Car Consist systems.

17.1.1.3.5 Instructions for using the OCS Inspection System, Wire Maintenance Lifts, Wire Handling Devices, and Wire Reels.

17.1.1.3.6 Instructions for emergency rescue in case of in-service failures.

17.1.1.4 The Contractor shall develop a complete User Education Program Plan, which shall include sufficient detail to enable the MBTA to evaluate and approve the adequacy of the proposed User Education Program.

17.1.1.5 The User Education Program Plan shall be submitted, for MBTA's review and approval, within 180 days from NTP. [CDRL 17.1.1.4]

17.1.1.6 The User Education Program Plan shall include a brief description of the scope of instruction for each discipline, hours of classroom and field instruction, qualifications required for instructors, a list of training aids, and the proposed schedule for training.

17.1.1.7 The User Education Program Plan shall be divided into the following disciplines:

17.1.1.7.1 OCS Inspection Car Consist Operation

17.1.1.7.2 OCS Inspection and Ancillary Equipment Operation

17.1.1.7.3 OCS Inspection Car Consist Maintenance, Overhaul, and Repairs

17.1.1.8 The Contractor shall perform the User Education Program in accordance with the approved User Education Program Plan.

17.1.1.9 A detailed resume for each instructor shall be provided to the MBTA for approval six months before initiation of the User Education Program. [CDRL 17.1.1.9]

17.1.1.9.1 Instructors shall be fully capable of transmitting in-depth technical information that can be understood by all MBTA participants.

17.1.1.9.2 Instructors shall have an in-depth knowledge of the system under discussion, how it interfaces with other systems or subsystems, the procedures for isolating faults and troubleshooting, and be able to communicate that information to students in an effective manner.

17.1.1.9.3 Instructors shall fluently speak the English language.

17.1.1.10 The education program shall include a mixture of classroom and hands-on instruction.

17.1.1.11 The Contractor shall assume that personnel being trained have no prior knowledge of the vehicle features.

17.1.1.12 All courses of instruction shall be performed on the MBTA's property at classroom and site areas designated by the MBTA. The MBTA will provide classroom facilities and space for storing training aids.

17.1.1.13 The Contractor shall coordinate all aspects of the user education program with the MBTA's Program Manager, as well as designated representatives of the Training and Operations Departments.

17.1.2 Training Materials

17.1.2.1 All manuals, documents, data, presentation materials, handouts, electronic files, and all other items used during the User Education Program shall be submitted, for MBTA's review and approval, prior to beginning the User Education Program. [CDRL 17.1.2.1]

17.1.2.1.1 Any equipment modifications performed during the Warranty Period shall be reflected in a new set of training documents, subject to MBTA's Review and Approval.

17.1.2.2 All User Education Program materials shall become the property of the MBTA at the conclusion of the Program.

17.1.2.3 The Contractor shall provide training materials in an approved digital format. [CDRL 17.1.2.3]

17.1.3 Training Sessions

17.1.3.1 The User Education Program shall include the following independently-conducted training sessions.

17.1.3.1.1 OCS Inspection Car Consist Operation: Four sessions for four students each

17.1.3.1.2 OCS Inspection and Work Equipment Operation: Four sessions for six students each

17.1.3.1.3 OCS Inspection Car Consist Maintenance, Overhaul, and Repairs: Four sessions for four students each

17.1.3.2 Training session duration shall be proposed by the Contractor, for MBTA's review and approval, in the User Education Program Plan.

17.1.3.3 The initial training sessions shall be scheduled to coincide with delivery of the first OCS Inspection Car Consist at the MBTA's property.

17.1.3.4 **OCS Inspection Car Consist Operation**

17.1.3.4.1 The OCS Inspection Car Consist Operation training sessions shall include instruction on the following items:

17.1.3.4.1.1 Requirements to safely and efficiently operate the vehicle; locate, operate, and understand all cutouts, circuit breakers, switches, access panels, indicators, and devices; locate and understand the meaning of all interior and exterior indicating lights and gauges; understand the meaning of any display messages; and proficiently operate the car in accordance with the MBTA's operating rules and regulations.

17.1.3.4.1.2 Descriptions of all emergency and disabled car conditions and subsequent steps required to move and/or tow the disabled cars.

17.1.3.4.1.3 Detection and resolution of problems and emergencies so as to minimize equipment downtime and avoid further damage.

17.1.3.4.1.4 Requirements for emergency services and first responders with respect to emergency access to the vehicle and making the vehicle safe to work on or around.

17.1.3.5 **Inspection and Work Equipment Operation**

17.1.3.5.1 The Inspection and Work Equipment Operation training sessions shall include instruction on the following items:

17.1.3.5.1.1 Safely and efficiently operating the OCS wire inspection system, wire maintenance lifts, wire handling devices, and wire reels in accordance with MBTA's operating rules and regulations.

17.1.3.5.1.2 Locate, operate, and understand all related cutouts, circuit breakers, switches, access panels, indicators, display messages, annunciators, and gauges.

17.1.3.5.1.3 Safely store materials and use equipment tie-downs.

17.1.3.5.1.4 Locate and use emergency brake activators.

17.1.3.5.1.5 Detection and resolution of problems and emergencies so as to minimize equipment downtime and avoid further damage.

17.1.3.6 **OCS Inspection Car Consist Maintenance, Overhaul, and Repair**

17.1.3.6.1 The OCS Inspection Car Consist Maintenance, Overhaul, and Repair training sessions shall include instruction on the following items:

17.1.3.6.1.1 Requirements to safely and efficiently service, inspect, maintain, adjust, troubleshoot, repair, and replace all equipment; locate, operate, and understand all cutouts, circuit breakers, switches, access panels, indicators, display messages, annunciators, and gauges; and proficiently maintain, overhaul, and repair the OCS Inspection Car Consists and all related equipment in accordance with the MBTA's operating rules and regulations.

17.2 MANUALS AND DOCUMENTATION

17.2.1 General

17.2.1.1 The Contractor shall furnish the following manuals and catalogs for use by the MBTA personnel.

17.2.1.1.1 Operation Manual

17.2.1.1.2 Inspection, Maintenance, and Overhaul Manual

17.2.1.1.3 Illustrated Parts Catalog

17.2.1.2 Manuals furnished under this Contract shall be complete, modern, thoroughly organized, and authentic with no extraneous or irrelevant information.

17.2.1.2.1 The material in the inspection, maintenance, and overhaul manual shall be similarly organized and indexed to the illustrated parts catalog using a standard numbering system.

17.2.1.2.2 All manuals shall clearly identify all hazardous materials and equipment.

17.2.1.2.3 All maintenance procedures involving hazards shall contain clear identification of the hazard and instructions to minimize or eliminate the hazards during the procedure.

17.2.1.2.4 Maintenance manuals, procedures, and training shall indicate the proper handling, storage, and disposal of hazardous materials.

17.2.1.3 Each manual shall be divided, to the extent required by the subject matter, into chapters to facilitate looking up specific topics or tasks.

17.2.1.4 The format of the manuals shall be consistent from chapter to chapter.

17.2.1.5 Each chapter shall include, at a minimum, the following topics:

17.2.1.5.1 General system and subsystem functional descriptions, including interfaces with other systems and subsystems.

17.2.1.5.2 Block diagrams, signal flow diagrams, functional schematics, wiring diagrams, and piping diagrams, as applicable.

17.2.1.5.3 Software descriptions and parameters.

17.2.1.5.4 Troubleshooting and failure tree.

17.2.1.6 The Contractor shall submit four complete sets of draft manuals, along with digital copies in an approved format, for MBTA's review and approval, at least 20 working days before delivery of the first OCS Inspection Car Consist. [CDRL17.2.1.6]

17.2.1.7 The Contractor shall submit nine copies of the updated and approved manuals with delivery of the last car. [CDRL 17.2.1.7]

17.2.1.7.1 Any equipment modifications performed during the Warranty Period shall be reflected in a new set of manuals, subject to MBTA's Review and Approval.

17.2.2 Operation Manual

17.2.2.1 The Operation Manual shall serve to instruct personnel on how to safely operate the equipment.

17.2.2.2 The Operation Manual shall contain a general overview of the equipment, startup inspection procedures, instructions for OCS Inspection Car Consist operation, and emergency rescue procedures.

17.2.2.3 The Operation Manual shall also include:

17.2.2.3.1 Description of all operating controls and all equipment inspected by the operator. The descriptions shall cover operating principles to provide the operator with a basic understanding of how the equipment functions.

17.2.2.3.2 Description of all movement and control equipment related to operation, startup inspection, equipment testing, and troubleshooting.

17.2.2.3.3 Description of all OCS wire inspection system, wire maintenance lifts, wire handling devices, and wire reel equipment related to operation, inspection, startup, shutdown, troubleshooting, and capacity.

17.2.3 Inspection, Maintenance, and Overhaul Manual

17.2.3.1 The Inspection, Maintenance, and Overhaul Manual shall instruct inspection and maintenance personnel on how to safely and efficiently service, inspect, maintain, adjust, troubleshoot, repair, overhaul, and replace equipment to ensure that the OCS Inspection Car Consists remain in proper working order.

17.2.3.2 At a minimum, the following information shall be provided:

17.2.3.2.1 Periodic inspection procedures, including wear limits, adjustments, tolerances, and related information.

17.2.3.2.2 Lubrication and fluid refill instructions, including specifications and capacities of all fluids and lubricants, schedule, and access locations.

17.2.3.2.3 Cleaning schedule and materials.

17.2.3.2.4 Troubleshooting guide.

17.2.3.2.5 Equipment removal and replacement procedures.

17.2.3.2.6 Manufacturer's recommended maintenance and overhaul schedule and procedures, including instructions for assembly, disassembly, tagging, shipping, cleaning, inspection, and testing, as well as details such as condemning limits, acceptance/rejection criteria, adjustments, tolerances, torque values, and related information.

17.2.3.2.7 Bills of material for maintenance and overhaul activities.

17.2.3.2.8 Schematics, photographs, and figures for parts and special tools.

17.2.4 Illustrated Parts Catalog

17.2.4.1 The illustrated parts catalog shall contain figures showing the breakdown of all systems, assemblies, and subassemblies that can be disassembled, reassembled, or replaced.

17.2.4.2 The illustrated parts catalog shall contain a cross-reference between all components shown in the figures and the component's quantity, description, drawing number, OEM name and part number, Contractor part number, the MBTA stock number, and commercial equivalents.

17.2.4.3 Cutaway isometric and exploded drawings shall be used to permit identification of all components.

17.2.4.4 Components common to different assemblies shall have the same Contractor's number.

17.2.4.5 In the case of hardware such as nuts, bolts, washers, etc., information relative to material, coating, dimensions, type, and classification shall be included.

17.2.4.6 The illustrated parts catalog shall include a column for the MBTA stock number.

17.3 TEST AND INSPECTION EQUIPMENT

17.3.1 General

17.3.1.1 The Contractor shall determine the required portable test equipment, bench test equipment, special tools, and support shop tools that are necessary to maintain, troubleshoot, and repair the OCS Inspection Car Consists. These items are referred to as "Test and Inspection Equipment" throughout this Specification.

17.3.1.2 Documentation and drawings related to Test and Inspection Equipment shall be provided for review as part of the Intermediate Design Review package. [CDRL17.3.1.2]

17.3.1.3 The Contractor shall provide all Test and Inspection Equipment prior to delivery of the first OCS Inspection Car Consist.

17.3.1.4 Test and Inspection Equipment, as well as the related documentation and drawings, shall be updated to address any equipment modifications performed during the Warranty Period. All updates are subject to MBTA's Review and Approval.

17.3.2 Portable Test Equipment (PTE)

17.3.2.1 PTEs shall be furnished for all onboard systems to aid the maintenance staff in maintaining, troubleshooting, and repairing the OCS Inspection Car Consists equipment.

17.3.2.2 The PTEs shall be state-of-the-art, high performance, laptop computers delivered upon arrival of the first OCS Inspection Car Consist to the MBTA property.

17.3.2.3 The PTEs shall conform to MIL-STD-810G certification for 3ft drop and have IEC 60529 IP53 dust and moisture protection or equivalent.

17.3.2.4 Any equipment used in conjunction with the PTEs, such as response/output indicators and input signal generators, shall be of an industrial grade.

17.3.2.5 The Contractor shall furnish four sets of PTEs, software (including licenses) and accessories (two PTEs for each transit line).

17.3.2.6 Complete parts lists and schematic diagrams of the PTE and instructions concerning how to use them for their intended purpose shall be included in the appropriate manuals.

17.3.2.7 Cable harnesses connecting the PTE to the vehicle systems shall be standardized for all systems.

17.3.2.7.1 Drawings of custom cable harnesses, if used, shall be provided with sufficient information to manufacture the harness.

17.3.2.8 Power required for operation of the PTEs and associated equipment shall be supplied by the OCS Inspection Car Consist.

17.3.2.8.1 It shall not be necessary to remove, dislodge, dismount, or disconnect any component in order to connect to the PTE.

17.3.2.9 The PTEs shall include all cables, industrial grade connectors and associated equipment to interface with the test points.

17.3.2.10 Test points shall be conveniently located on the OCS Inspection Car Consist so that the maintenance person is able to observe the functioning of the specific system under test.

17.3.2.11 **Functional Requirements**

17.3.2.11.1 The function of the PTEs shall be to produce all of the operating commands and other input signals necessary to fully exercise all functions and components of the particular system or subsystem under test, and to measure or indicate all of the signals, responses and outputs produced by a system by means of indicators such as lamps, meters, oscilloscopes, or gauges.

17.3.2.11.2 When used according to the instructions supplied by the Contractor, each PTE shall enable the maintenance technician to fully check and calibrate the System or Subsystem under test and to locate and replace any removable Component which has fully or partially failed.

17.3.2.11.3 Response indicators and input-signal generators shall be built into the PTEs to the maximum extent possible and have sufficient accuracy for the function being performed.

17.3.2.11.4 System status and functional information shall be provided in a graphical format, superimposed over a system diagram or schematic.

17.3.2.11.4.1 When a graphic presentation is not feasible, system status and functional information shall be provided in English language statements and relevant engineering units and be formatted for easy readability.

17.3.2.11.4.2 Look-up tables or other references to translate various codes into human comprehensible text is unacceptable.

17.3.2.11.5 PTEs shall operate under the Microsoft Windows environment.

17.3.2.11.6 All user interaction with the software shall be consistent with established Windows conventions.

17.3.2.11.7 The PTE and associated equipment shall be portable and suitable for industrial service for use on the repair shop floor, in pit locations, and in the yard.

17.3.2.11.7.1 The test equipment shall be self-protected in the event of an overload or short circuit condition.

17.3.2.11.8 All PTEs that will enable reprogramming of control software shall be password protected.